SPECTRAL DYNAMICS CORPORATION

SERIAL 61

INSTRUCTION MANUAL

MODEL 13105-1
LOW FREQUENCY TRANSLATOR

PATENT PENDING

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MODEL 13105-1 LOW FREQUENCY TRANSLATOR

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MANUAL CHANGES

Model: 13105-1
Unit Serial: As Applicable
Manual Edition: ----

Each change listed below must be individually analyzed for applicability in accordance with "Action" directed relative to unit serial number and/or documentation affected.

Change #1
ECO-963
(5-20-71)

Effectivity: S/N 031 and on.

Action: Schematic, DWG. NO. 13281(B), Translation Loop Assembly 12966-1, (Circuit Card A8);

Change	From	To
R35	100Ω, 1/4W, 5%	100Ω, 1/8W, 1%
R42	2.7k, 1/4W, 5%	2.74k, 1/8W, 1%
R43	36k, 1/4W, 5%	36.5k, 1/8W, 1%
R55	1.3k, 1/4W, 5%	1.3k, 1/8W, 1%

Change #2
ECO-971
(6-3-71)

Effectivity: S/N 033 and on.

Action: Schematic, DWG. NO. 13275(B), I.F. Modulator Assembly 12958-1, (Circuit Card A2); change tolerance of resistors R40 through R47 from 1% fo 0.1%.

Change #3
ECO-1138
(7-17-72)

Effectivity: S/N 048 and on.

Action: Schematic, DWG. NO. 13281(B), Translation Loop Assembly 12966-1, (Circuit Card A8);

Change R55 from 1.3k to 1.58k.

Add the symbol △5 adjacent to R55 and the following to the notes located above the title block:

△5 Factory selected with typical value shown.

Change #4
ECO-1366
(12-22-72)

Effectivity: S/N 063 and on.

Action: Schematic, DWG. NO. 13281(B), Translation Loop Assembly 12966-1 (Circuit Card A8); Change R30 from 12k to 10k. Change R33 from 1.5k to 1.8k.

Change #5
ECO-1523
(8-10-73)

Effectivity: S/N 023 and on.

Action: Schematic, DWG. NO. 13274(D), Input Assy. 12956-1 (Circuit Card A1); Add capacitor C24, 39 pF/5%, connected across the base and collector of transistor Q3.

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*Revised (8-31-71)

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DWG. NO. 13277	Circuit Card A4/A5	Low Pass Filter	Assembly 12952-1
DWG. NO. 13279	Circuit Card A6	F.S.O.	Assembly 12962-1
DWG. NO. 13280	Circuit Card A7	Multiplier No. 2	Assembly 12964-1
DWG. NO. 13281	Circuit Card A8	Translation Loop	Assembly 12966-1
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DWG. NO. 13283	Circuit Card A10	Local Oscillators	Assembly 12968-1
DWG. NO. 13284	Circuit Card A11	Master Clock System	Assembly 12970-1
DWG. NO. 13264	Circuit Card A12	Power Supply	Assembly 13262-1
DWG. NO. 12944	Interconnecting Diagram, Model 13105		

PREFACE

RECEIVING INSPECTION PROCEDURE

The Model 13105 Low Frequency Translator is shipped fully assembled, packed in a polystyrene case designed to protect it against all normal shipping hazards. Immediately upon receipt, inspect the exterior of the shipping case and note any visible damage. Keep all forms and invoices attached to the shipping case. Remove the instrument from the shipping case and test its functional operation in accordance with Section II of this manual. If shipping damage is apparent, file a claim with the carrier's claims agent and send a copy to Spectral Dynamics Corporation. Be sure to include the instrument name, model number, and serial number on all correspondence. Spectral Dynamics Corporation will advise the buyer what should be done; arrangements for repair or replacement will be made as applicable.

WARRANTY POLICY

All Spectral Dynamics products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain components listed in some of the operating manuals, for the specified period. We will repair or replace products which prove to be defective during the warranty period, providing the failure or damage has not been caused by misuse or abnormal operating conditions. Fuses and lamps are specifically excluded from warranty. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate of cost to repair will be submitted to the purchaser for approval before beginning any repair work.

Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory, with transportation charges prepaid by the purchaser. No other warranty is expressed or implied. We are not liable for consequential damages.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, and the name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via air freight to the factory or authorized repair station indicated on the instructions. Replace the instrument in its original shipping case, or surround with two to three inches of shock absorbing material and then pack it in a heavy-weight cardboard box, wooden box, or other strong container.

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Model 13105 Low Frequency Translator selects a 10-Hz wide to 500-Hz wide band of frequencies (window) from a 10 to 5000-Hz input signal, and then translates the narrow band down in frequency to one of four low frequency ranges. (Refer to Figure 1-1.) The low frequency ranges correspond to the four lowest analysis ranges of the Spectral Dynamics SD301 series Real Time Analyzers.

All of the Model 13105 input and output functions are compatible with the Models SD301A and SD301B Real Time Analyzers. Some earlier units of the SD301 series require one additional internal connection as outlined in Paragraph 2.2.1, Section II.

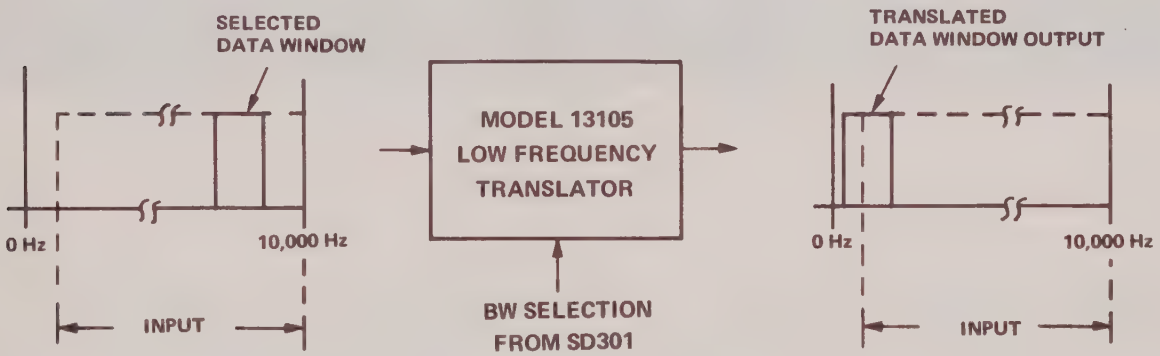


Figure 1-1. The Function of the Model 13105 Low Frequency Translator.

The following abbreviations are used throughout this manual:

f_{ctr} = input center frequency = center of selected data window

f'_{ctr} = output center frequency = center of translated data window

f_r = input center frequency reference (modulator carrier) = 100 kHz + f_{ctr}

f'_r = output center frequency reference (demodulator carrier) = 100 kHz + f'_{ctr}.

1.2 FRONT PANEL FUNCTIONAL DESCRIPTION

Figure 1-2 is a front-panel view of the Model 13105 Low Frequency Translator. Following is a functional description of the front-panel controls and indicators.

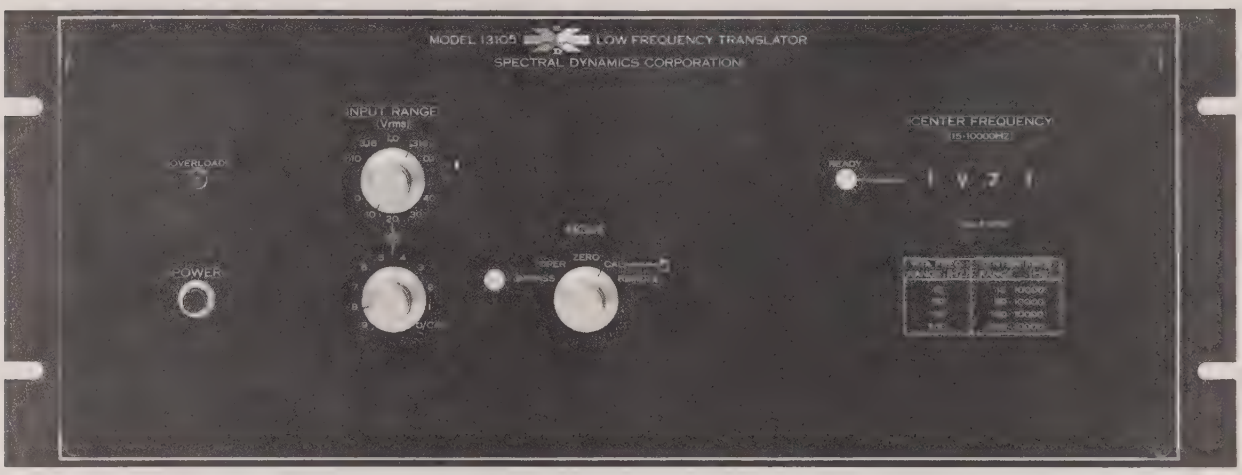


Figure 1-2. Front Panel

POWER Switch/Indicator

Push button-type switch/indicator used to turn instrument on and off. Push button lights when power is on.

INPUT RANGE Selectors

Coarse and fine range switches provide 0 to 49-dB attenuation of the input signal in 1 dB steps. The total attenuation equals the sum of both switch settings.

Coarse INPUT RANGE switch selects input signal range 0.1 Vrms to 10 Vrms in 10 dB steps.

Fine INPUT RANGE switch provides 9-dB range in 1 dB steps to give complete coverage between the 10-dB steps of the coarse switch settings.

OVERLOAD Indicator

Lights when input level exceeds selected INPUT RANGE by approximately 7 dB. Select successively higher input ranges until light goes out.

MODE Selector

BYPASS . . . . . When selected, the DATA INPUT is connected directly to the TRANSLATED DATA output connector for application to the SD301, bypassing the Low Frequency Translator circuitry. The Translator is in standby condition, and the BYPASS indicator is lit.

NOTE

The instrument will go into BYPASS only when turned on and with power applied.

OPER

When selected, the Translator is in the normal operating mode as described in Section II of this manual.

ZERO

When selected, and with INPUT RANGE selector set to 0/CAL, zero signal level is supplied to the SD301, providing a zero reference point for external recorder or display calibration.

CAL

*When selected, and with INPUT RANGE selector set to 0/CAL, an internally generated calibration signal of .316 Vrms is supplied to the SD301. The calibration signal level is adjusted for correct full-scale output from the SD301 by the front-panel CAL screwdriver control. The CENTER FREQUENCY selector must be set to 1000.

REMOTE

When selected, the internal center frequency reference signal is controlled by a digital signal applied to rear-chassis connector J6; the front-panel CENTER FREQUENCY selector has no effect. The frequency data must be applied to J6 as a 4-digit parallel-BCD signal compatible with 7400 series TTL IC logic. Bandwidth control must be applied at J6 rather than J5.

*Revised (2-17-72)

BYPASS Indicator

See MODE selector, BYPASS position, above.

MODE CAL Adjustment

See MODE selector, CAL position, above.

CENTER FREQUENCY Selector

Four-digit, thumbwheel switches select the frequency which will be center of the range to be translated (window). (Bandwidth of window equals SD301 ANALYSIS RANGE UPPER LIMIT setting.) CENTER FREQUENCY must be chosen within the ranges specified on chart below the selector; the range depends upon the SD301 ANALYSIS RANGE setting. If SD301 ANALYSIS RANGE is set to a position above 500 Hz, the translator automatically goes into BYPASS mode.

READY Indicator

Lights to indicate that instrument is ready to operate at selected center frequency. Indicator will go out momentarily when CENTER FREQUENCY selector setting is changed. The center frequency changes at the rate of approximately 400 Hz/s after selection is made.

1.3 REAR OF CHASSIS FUNCTIONAL DESCRIPTION

Figure 1-3 is a rear-chassis view of the Model 13105 Low Frequency Translator. Following is a functional description of the rear-panel components.

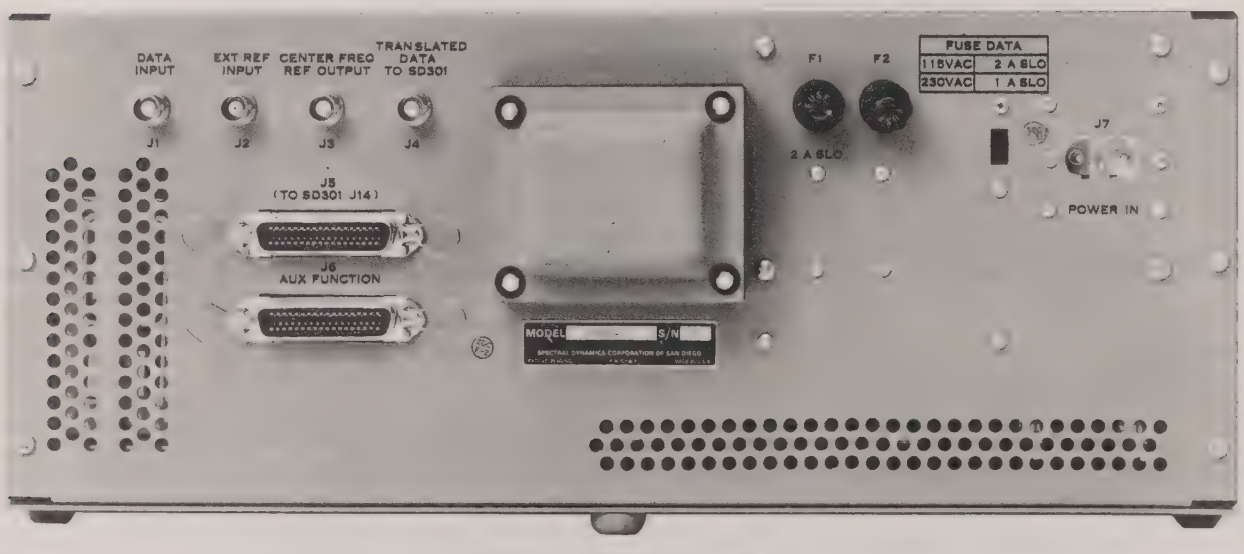


Figure 1-3. Rear of Chassis

DATA INPUT (J1)

Used to apply data input signals to instrument for translation and subsequent analysis by SD301.

EXT REF INPUT (J2)

Accepts an optional external-reference signal, 100 kHz plus center frequency, to determine center frequency of band to be translated. To operate using the EXT REF INPUT, Pin 21 of J6 must be grounded; in this condition, the front-panel CENTER FREQUENCY selector and READY indicator do not affect translation. Reference signal input must be compatible with 7400 series TTL IC logic.

NOTES

1) When instrument is operated from external reference source, the output at J3 is still determined by the internal source.

2) When instrument is operated from external reference source and in CAL mode, the external source is the calibration signal and must be set to 1000 Hz.

CENTER FREQ REF OUTPUT (J3)

Provides an output signal whose frequency is equal to the center frequency set on the CENTER FREQUENCY selector. With MODE selector set to REMOTE, the frequency is determined by the digital BCD number applied to J6, the AUX FUNCTION connector.

When instrument is operated from the external reference source applied to J2, this output is not affected; its frequency is still determined by the internal source.

TRANSLATED DATA TO SD301 (J4)

Provides the translated data for application to the SD301. Output is compatible with the SD301 input requirements.

TO SD301 J14 (J5)

Accepts bandwidth-control logic from SD301 J14 connector, and provides VCO control from Translator to SD301.

AUX FUNCTION (J6)

Used to apply digital BCD input for REMOTE MODE control of internally generated reference frequency. The BCD number applied must be a four digit representation of the center frequency in Hz.

EXAMPLE: If the center frequency is to be 186 Hz, the input to J6 must represent the number 0186, i.e., 0110 1000 0001 0000.

Pins 25, 26, 27 and 28 are used for remote bandwidth control; the pins are grounded to provide 10, 50, 100 or 500 Hz bandwidths respectively.

F1 (2A SLO)

Fuse receptacle for +5 Vdc line. Accepts 3AG-type, 2A, SLO-BLO fuse.

F2

Fuse receptacle for primary power input. Accepts 3AG-type fuse. 2A SLO BLO for 115 Vac and 1A SLO BLO for 230 Vac operation.

115/230 Selector

Two-position slide switch used to select between 115 and 230 Vac operation. In either position, proper primary-power-input voltage appears in window. Switch is operated with screwdriver blade inserted into the slot provided.

POWER IN (J7)

Accepts 3-wire plug and cable (supplied) for applying 115/230 Vac, 50—400 Hz primary input power. Center terminal is chassis ground. Uses Belden No. 17258-S cable.

1.4 SPECIFICATIONS

Frequency Ranges

The following table gives the resolution, input frequency range, and output frequency range associated with each of the four possible choices of bandwidth. Figure 1-4 is a generalized spectrum chart relating these parameters to the SD301 parameters.

ANALYSIS BANDWIDTH	ANALYZER RESOLUTION	FREQUENCY RANGE OF UNFILTERED INPUT	FREQUENCY ** RANGE OF TRANSLATED DATA
10 Hz	0.02 Hz	10 Hz – 10 kHz	1.0 – 11 Hz
50 Hz	0.10 Hz	25 Hz – 10 kHz	5.0 – 55 Hz
100 Hz	0.20 Hz	50 Hz – 10 kHz	10.0 – 110 Hz
500 Hz	1.00 Hz	250 Hz – 10 kHz	50.0 – 550 Hz

**SD301 ANALYSIS RANGE is automatically offset by $\frac{BW}{10}$ to match these ranges.

Data Output

*→ Amplitude . . . . . 0.316 Vrms = full scale

Linearity . . . . . ±0.5 dB to at least -50 dB referenced to full scale

NOTE

The TRANSLATED DATA OUTPUT linearity cannot be measured directly from J6. To measure "within the data bandwidth", an analyzer must be used to remove the out-of-band noise. This is because the Translator output extends beyond 50 kHz, depending upon the RTA aliasing filter to provide the proper cutoff.

Impedance . . . . . <500 Ohms

*Revised (3-15-71)

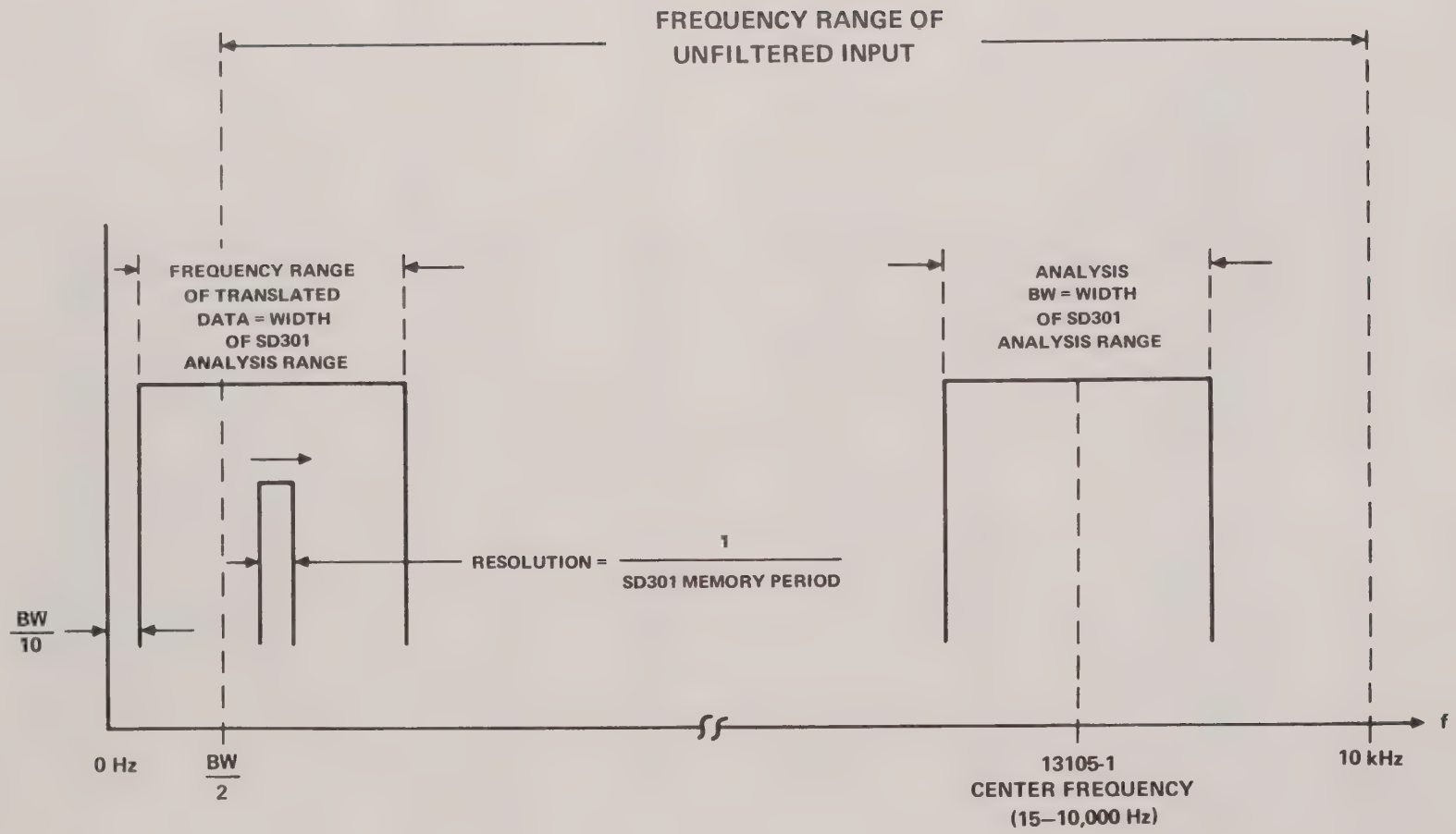


Figure 1-4. Interpretation of Frequency Specifications

Reference Signal Output

Amplitude . . . . . ≈4.5V p-p square wave

Impedance . . . . . <600 Ohms

Range . . . . . 15–10,000 Hz, 1-Hz increments

Stability

Short Term . . . . . 0.002% in 24 hours

Long Term . . . . . 0.01% in 6 months

Data Window and Filter Response (See figure below)

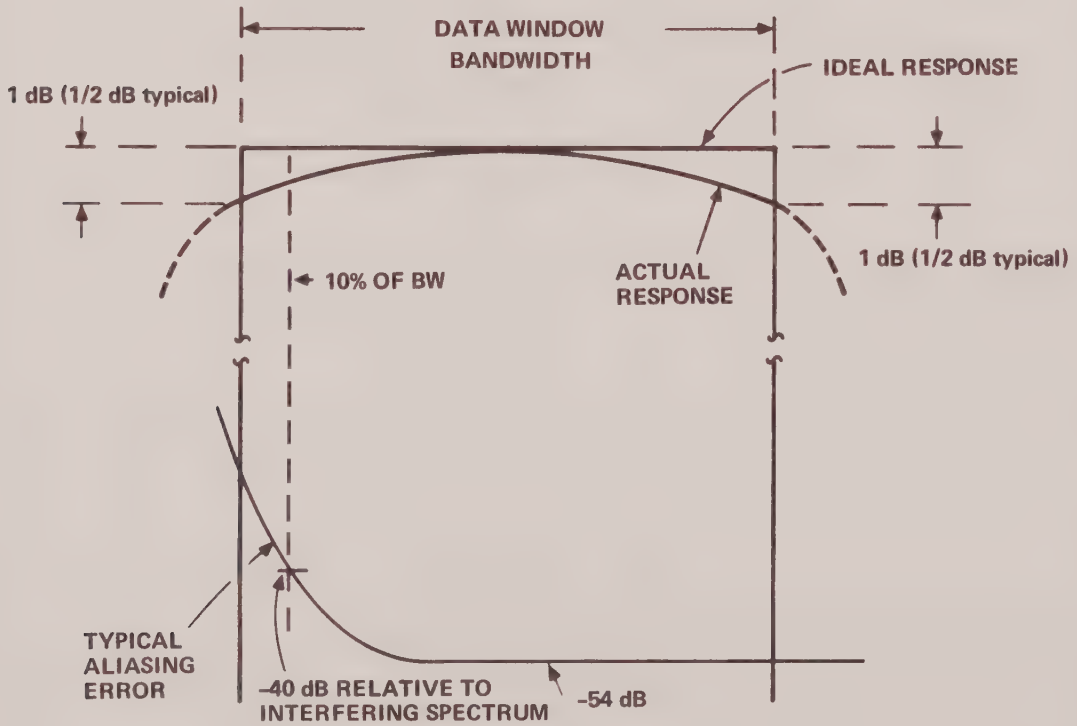


Figure 1-5. Data Window and Filter Response

Input

Amplitude		0.1 Vrms to 10 Vrms (max)
Impedance		100k Ohms

Miscellaneous

Power		115/230 Vac, 50–400 Hz, ≈100W
Dimensions	Height	17,8 cm (7")
	Width	48,2 cm (19")
	Depth	35,6 cm (14")
	Weight	11 kg (24.4 lbs)

SECTION II

OPERATION

2.1 GENERAL

The Model 13105-1 Low Frequency Translator was designed specifically for use with the SDC SD301 series Real Time Analyzers (RTA). Refer to the appropriate RTA instruction manual for details pertaining to its operation and to Section I of this manual for description of the Translator front-panel and rear-of-chassis controls, indicators and connectors.

NOTE

If this is the initial installation of the Model 13105-1/RTA as a system, refer to Paragraph 2.5 Compatibility.

2.2 INITIAL POWERING PROCEDURE

a. Check that the 115/230 switch on instrument rear chassis is set according to the input line voltage used.

b. Check that fuses with the correct ratings are installed in the fuse receptacles F1 and F2. Fuse data is placarded on rear of chassis.

c. Connect power cord to primary power source.

d. Press the POWER switch/indicator; it should light indicating that power is applied to all internal circuits.

e. Instrument is ready to operate immediately. However, at least 30 minutes warm-up time should be allowed when optimum stability of the internal center frequency reference signal is required.

2.3 OPERATIONAL CHECKOUT PROCEDURE

Setup:

Interconnect the Model 13105-1 with the RTA unit per Figure 2-1, Page 2-4.

Connect the SPECTRUM LOG output from the RTA unit to the vertical input of a display unit.

Connect the FREQUENCY LIN output from the RTA unit to the horizontal input of a display unit.

Apply a 0.1 Vrms, 850 Hz, sine-wave signal to J1 on the rear of the Model 13105-1, and set the front-panel controls of Model 13105-1 and RTA unit as follows:

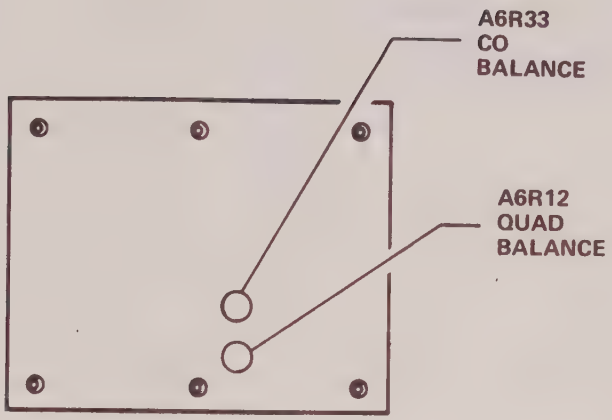
Model 13105-1

MODE . . . . . ZERO
RANGE 0/CAL
CENTER FREQUENCY . . . . . 1000 Hz

RTA Unit

OPER/CAL . . . . . OPER
OUTPUT GAIN . . . . . X1, 0 dB
MEMORY PERIOD . . . . . AUTO
MODE . . . . . SCOPE FAST
ANALYSIS RANGE . . . . . UPPER LIMIT 500
INPUT RANGE
(Coarse) 0.316
(Fine) 0/CAL
MEMORY . . . . . UPDATE

a. Observe that spectrum display shows no spectrum lines other than the normal amount of noise. A6R33 and A6R12 may be adjusted to minimize the "spur" at center of display; both controls are accessible through holes provided in the top cover, as illustrated in the following.



b. Set Model 13105 MODE to CAL and CENTER FREQUENCY to 3500. Observe that no 50-Hz sideband lines appear in the spectrum display.

c. Set Model 13105 MODE to OPERATE and CENTER FREQUENCY to 1000 Hz. Leave input at 850 Hz. Observe that no sideband lines over −46 dB appear in the spectrum display.

d. Step SD301 INPUT RANGE to UPPER LIMIT 100, 50, and 10 to check the remaining low-pass filters with input frequency at 970, 985, and 997 Hz respectively.

e. Set the Model 13105 MODE to BYPASS. The fundamental spectrum line should move down in frequency by 10% of bandwidth (50 Hz with SD301 ANALYSIS RANGE at UPPER LIMIT 500).

2.4 OPERATING PROCEDURES

The following procedures describe the operation of the Model 13105 Low Frequency Translator with the SD301 Real Time Analyzer. Operation with internal reference is described in subparagraph 2.4.1. Operation with remotely controlled internal reference and external reference are described in subparagraphs 2.4.2 and 2.4.3.

2.4.1 Setup for Operation with the SD301 Real Time Analyzer

a. Connect the Model 13105 to the SD301 as shown in Figure 2-1 below.

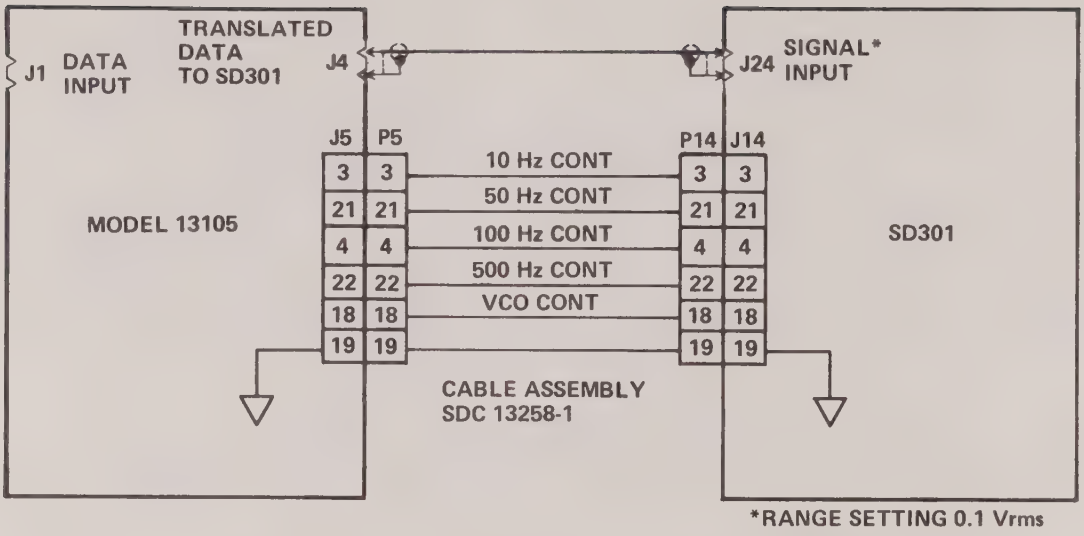
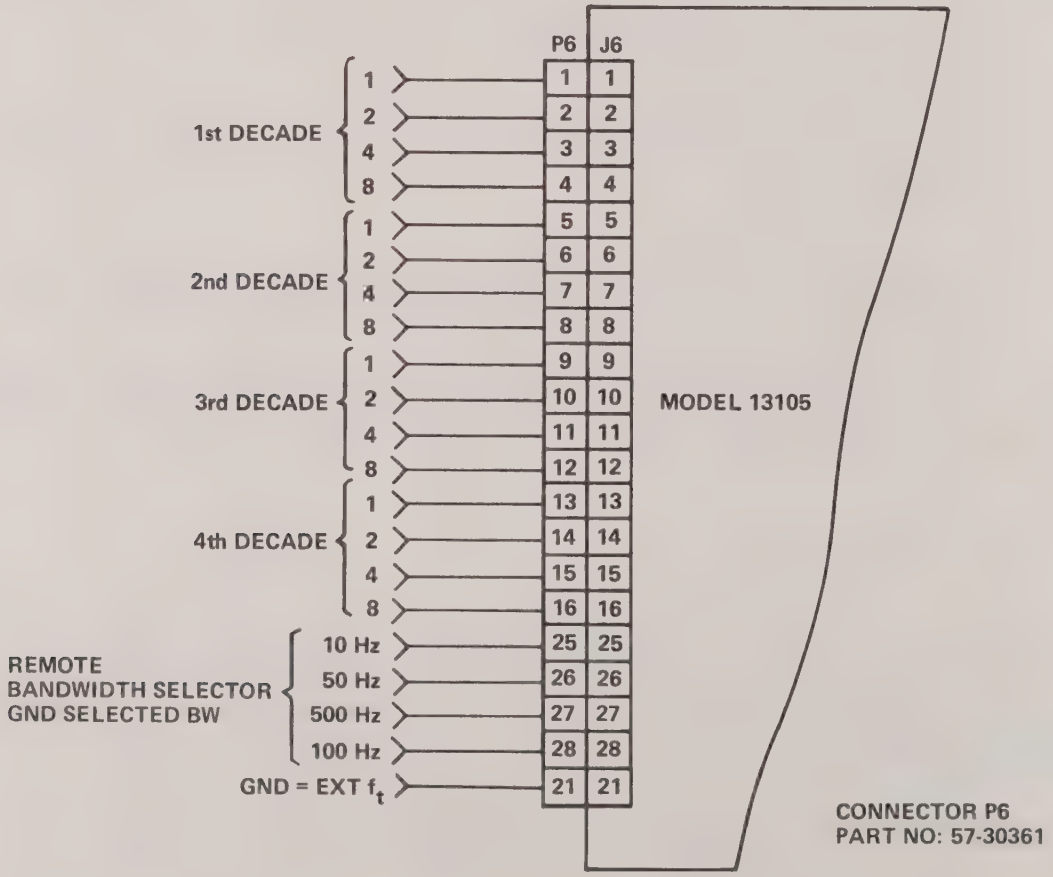


Figure 2-1. Model 13105/SD301 Interconnecting Diagram



*(Revised 1-14-72)

Figure 2-2. Remote CENTER FREQUENCY Selector Connections

b. Refer to the SD301 Instruction Manual and perform the powering and setup procedures applicable to the particular system test and display instrumentation. (The following procedure assumes that the signal to be analyzed is applied to the DATA INPUT connector, J1, of the Model 13105, and that the SD301 OUTPUT connections are made to an oscilloscope or plotter.

c. On the Model 13105, set the MODE selector to CAL.

d. Set CENTER FREQUENCY selector to 1000.

e. On the Model 13105, set the INPUT RANGE selector to 0/CAL position.

*f. On SD301, set the INPUT RANGE switch to .316, and adjust the fine INPUT RANGE switch (INPUT RANGE CAL potentiometer on SD301A) so that the INPUT NORMAL indicator is lighted.

g. The output display of the SD301 can now be calibrated to .316 full scale, using the MODE CAL screwdriver adjustment on the front panel of the Model 13105.

h. Now set the MODE selector to OPER and set the CENTER FREQUENCY selector for the center frequency of the band to be translated.

i. On the Model 13105, adjust the INPUT RANGE selector for the desired full-scale input level to the SD301. (If the Model 13105 OVERLOAD indicator lights during operation, select a higher setting.)

NOTE

It is normal for the uppermost lighted Input Range indicator on the SD301 to pulse at times during operation with the Low Frequency Translator.

j. The Model 13105 will translate the input signal frequency band down to a frequency that is compatible with the input of the SD301 as selected. All other operations are performed by the SD301 and associated instrumentation as described in the SD301 Instruction Manual.

2.4.2 Use of Remote Center Frequency Selector

If remote control of CENTER FREQUENCY is required, the following procedure should be used.

a. Connect J6 to a four-digit (16-bit) binary-coded-decimal source (series 7500 TTL IC compatible) and some means of selectively grounding Pins 25 through 28 for bandwidth selection as shown in Figure 2-2.

b. In paragraph 2.4.1 step h., set MODE selector to remote. Except for the center frequency selector, the instrument will function as in operate.

c. Now the center frequency selector on the instrument front panel will have no control over the internal reference frequency. Select the center frequency from the remote source only.

NOTE

To retain SD301 control over BANDWIDTH while using remote CENTER FREQUENCY control, connect Pins 25, 26, 27 and 28 of P6 to Pins 3, 21, 22 and 4 of P5 respectively.

2.4.3 Use of External Reference Frequency Signal

NOTE

The external-reference-source long-term and short-term stability and jitter directly affect the resolution obtainable in setting the center frequency of operation. In selecting a source, due consideration should be given to these stability factors.

To use an external reference frequency source for determining the center frequency of the band to be translated, follow the procedure below.

a. Apply a signal whose frequency is adjustable to 100 kHz plus the desired center frequency to J2.

EXAMPLE: For a center frequency of 900 Hz, center frequency = 100,000 Hz + 900 Hz = 100,900 Hz.

The signal must be compatible with series 7400 TTL IC logic.

*b. Ground J6 Pin 21. This can be done by installing a jumper in P6 from Pin 21 to Pin 35. By providing an external switch that can ground or open Pin 21, the internal or external reference frequency can be selected remotely.

c. With J6 Pin 21 grounded, set the external frequency source to 100 kHz plus the desired center frequency. In Paragraph 2.4.1 step d., set source to 101,000 Hz.

d. If CENTER FREQ REF OUTPUT, J3, is being used to monitor the center frequency, note that J3 continues to output the internally generated frequency even when Translator is operated with an external reference source.

2.5 COMPATIBILITY

Although the Model 13105 was designed to operate with all SD301A or B units, in some SD301A or B units with early serial numbers it is necessary to add a single internal connection from J14 Pin 18 to the VCO circuitry. This modification allows the Translator to offset the SD301 ANALYSIS RANGE by 10% of bandwidth. The point of connection to the VCO circuitry depends upon the model and/or possible modifications to the VCO circuitry. Check that this connection exists as described below:

- In Model SD301B units, the connection from J14 Pin 18 must be made to Pin 18 of receptacle XA22 (Current Generator Assembly 12444-3).

- In Model SD301A units with modified VCO circuitry, connection must be made to Pin 18 of XA35 (Current Generator Assembly 12444-3). Units with unmodified VCO circuitry DO NOT have circuit card A35.

- For proper connection in unmodified SD301A units or in earlier Model SD301 units, contact Spectral Dynamics Corporation, Customer Services Department.

*Revised (2-17-72)

To check that the VCO is offsetting properly, connect the Translator J5 connector to the RTA J14 connector with Cable Assembly 13258-1. Connect SD301 SPECTRUM LOG output to oscilloscope vertical input and SD301 FREQUENCY LIN output to oscilloscope horizontal input. Then perform the following steps.

a. Set the SD301 front-panel controls as follows:

INPUT RANGE 0/CAL
MEMORY . . . . . UPDATE
ANALYSIS RANGE . . . . . 500 UPPER LIMIT
OUTPUT GAIN . . . . . X1, 0 dB
MODE . . . . . SCOPE FAST

b. Perform Initial Powering Procedure, Paragraph 2.2.2. On the Translator, step the MODE selector between BYPASS and OPERATE and note that the fundamental spectrum line moves up in frequency by 10% of bandwidth (50 Hz) when instrument is in the OPERATE MODE. (The VCO is offset whenever the BYPASS indicator is not lit.)

c. If the frequency offset is not 10% of bandwidth when stepping the Translator MODE selector above, proceed with the following steps.

d. Set the SD301 front-panel controls as follows:

Sweep Initiation . . . . . AUTO
Frequency Offset . . . . . Middle of Range
(next to FREQUENCY-CAL)
DIGITAL LOCATOR . . . . INTENSITY MARKER } SD301B Only.
% FULL SCALE 000

e. On the SD301B, adjust the zero offset potentiometer, A22R14 (A35R14 in SD301A) until the frequency markers fall on the intensity markers. (This is a 10% offset.)

f. On the SD301A, set the FREQUENCY MARKERS switch to INT. Set MODE to MANUAL and MANUAL dial for ten marker divisions on the display. Adjust A35R14 until the spectrum line moves the distance between markers when the Translator MODE selector is stepped from BYPASS to OPER.

SECTION III

CONCEPT AND THEORY OF OPERATION

3.1 CONCEPT OF OPERATION

The Model 13105 Low Frequency Translator performs two functions.

- It separates a selected band of frequencies from the data signal.
- It translates the band of frequencies down to a lower frequency band.

As an example, Figure 3-1 illustrates the translation of a 50-Hz-wide band centered at 1000 Hz. The frequency, phase and amplitude relationships between the components of the 975 to 1025 Hz band are reproduced in the 5 to 55 Hz band.

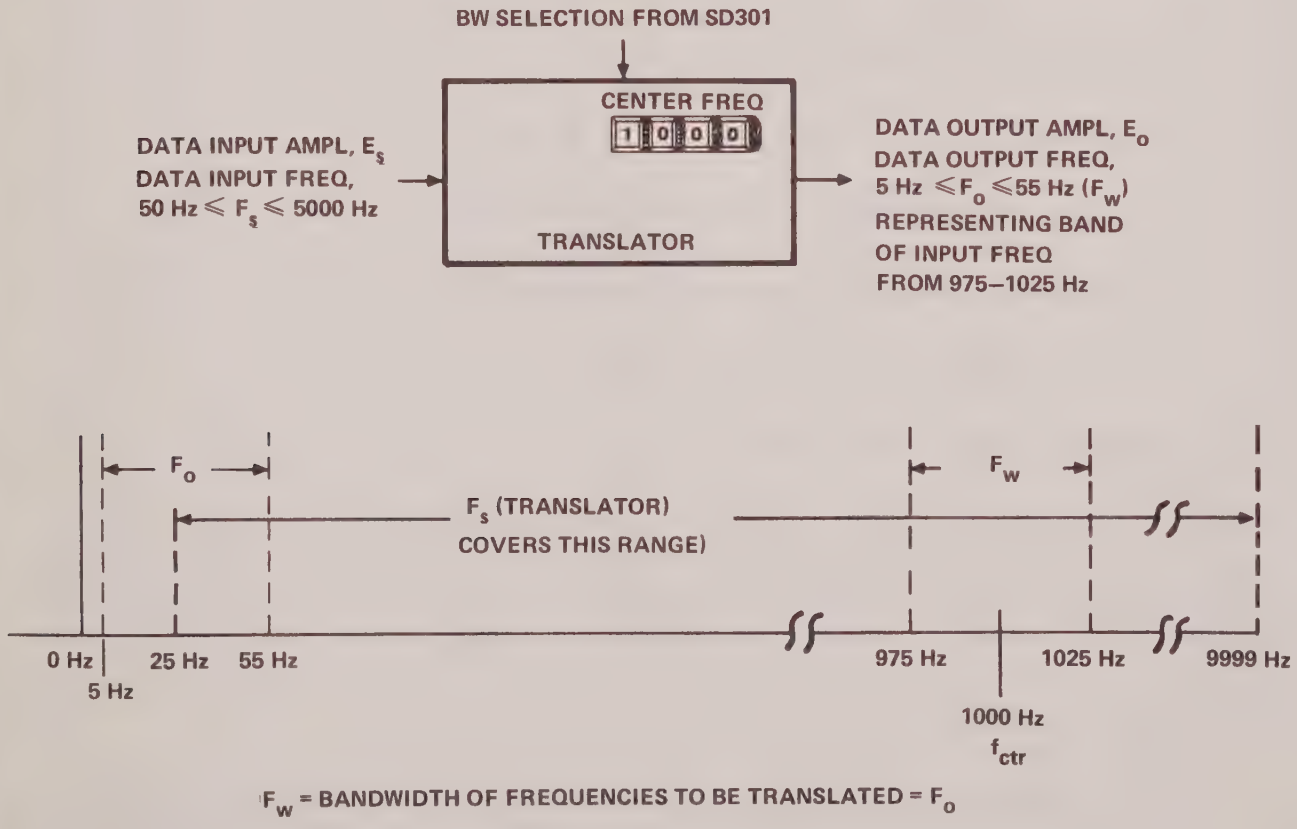


Figure 3-1. Concept of Operation

Figure 3-2 shows the Translator as composed of three basic sections. In the modulator section, the input signal is reconstructed at a higher frequency, with the center of the selected data window at 100 kHz. The 100-kHz filter section transmits the data-window information to the demodulator section, with bandwidth automatically selected to accommodate Analyzer bandwidth. In the demodulator section, the 100 kHz data is reconstructed at the lower, translated-data, frequency.

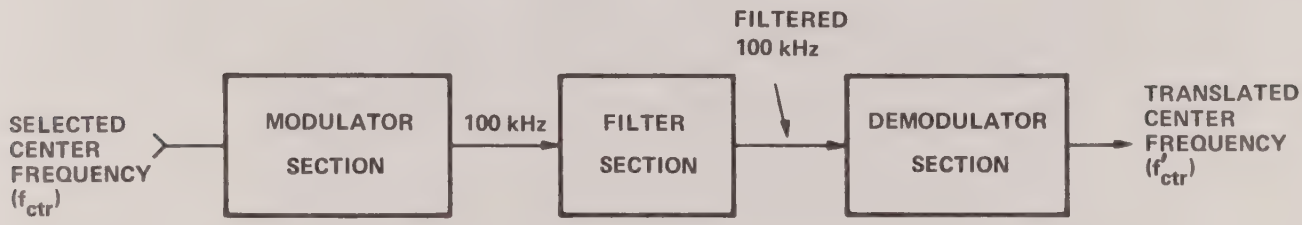


Figure 3-2. Basic Translation Process

The following abbreviations are used throughout this section:

f_{ctr} = input center frequency = center of selected data window

f'_{ctr} = output center frequency = center of translated data window

f_r = input center frequency reference (modulator carrier) = 100 kHz + f_{ctr}

f'_r = output center frequency reference (demodulator carrier) = 100 kHz + f'_{ctr}.

3.2 BLOCK DIAGRAM DESCRIPTIONS

The following paragraph 3.2.1, describes the Simplified Block Diagram shown in Figure 3-3. For the sake of clarity, the selectable bandpass filter, multiplier, modulator carrier generator, and demodulator carrier generator, are each shown as a single block. However each is described in detail in paragraphs 3.2.2 through 3.2.5, supported by separate block diagrams, Figures 3-4 through 3-7.

3.2.1 Simplified Overall Block Diagram

The following description assumes that the instrument is in the OPER MODE. It is assumed that a sine wave is applied to the input, and that its frequency is the same as the frequency set on the front-panel CENTER FREQUENCY selector.

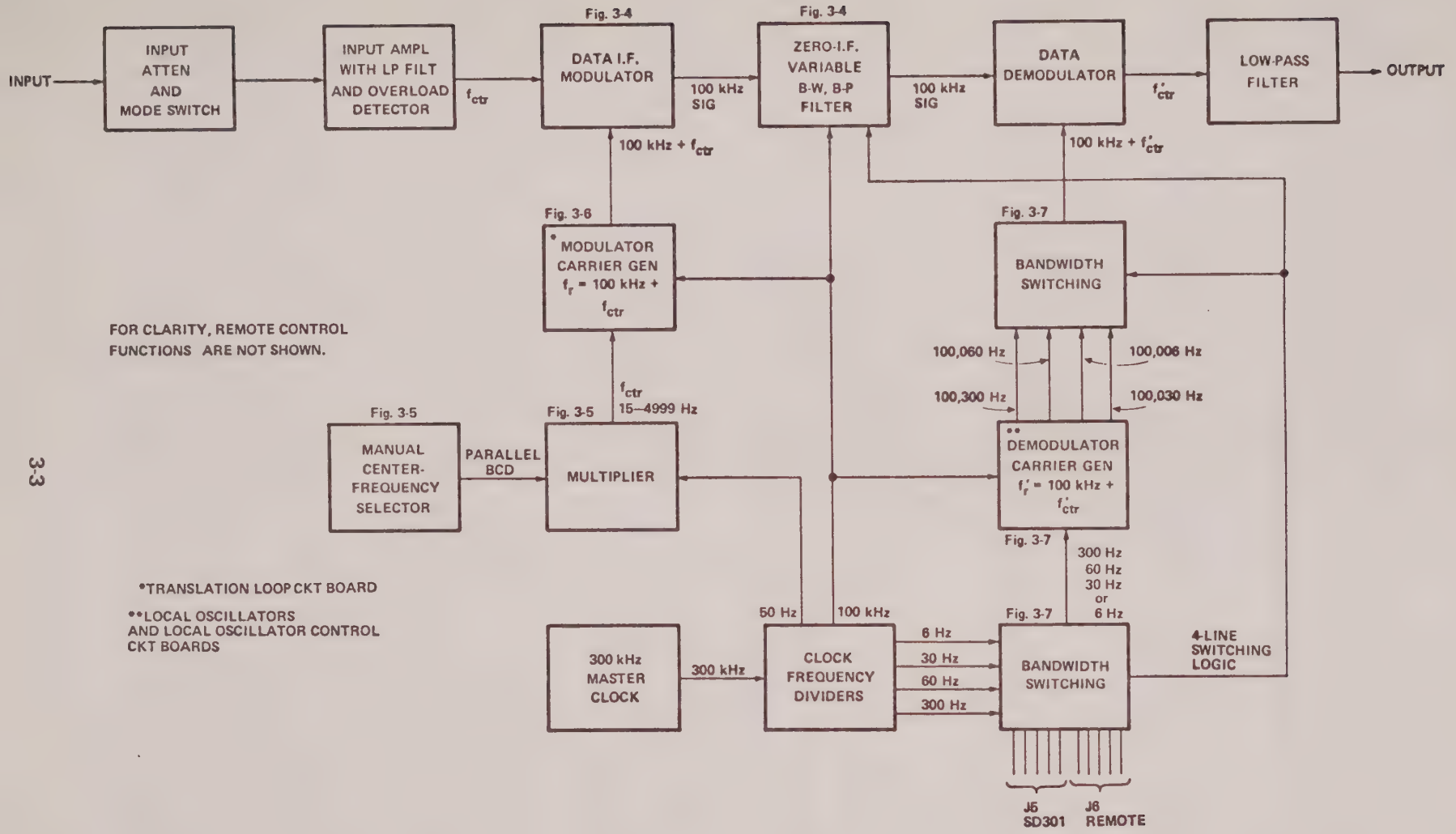


Figure 3-3. Simplified Overall Block Diagram

The input data is routed through the INPUT RANGE attenuator to the input amplifier. The signal is then passed through a low-pass filter that removes frequencies above 65 kHz. The overload detector lights the OVERLOAD indicator when the input-data level exceeds the INPUT RANGE attenuator setting by approximately 7 dB.

In the modulator, the data signal is mixed with a 100 kHz + f_{ctr} carrier. The carrier is suppressed, leaving the sidebands, 100 kHz + $2f_{ctr}$ and 100 kHz. Each sideband contains all of the amplitude and phase information of the original data signal.

The selectable-bandwidth bandpass filter transmits only the 100-kHz sideband to the demodulator. In the case of a complex data signal, other sideband components are also transmitted according to the selected bandwidth of the filter. The selectable-bandwidth filter is described in paragraph 3.2.2.

In the demodulator, the filtered signal is combined with a new carrier whose frequency is 100 kHz + f'_{ctr}, where f'_{ctr} is the new center frequency in the range to which the data is to be translated. The carrier is suppressed, leaving the lower sideband, f'_{ctr}, which still contains the original amplitude and phase information. The low-pass output filter removes the upper sideband. The translated data is available at the rear-chassis TRANSLATED DATA connector.

The carrier frequencies used in the modulator and demodulator are generated from the 300-kHz crystal-oscillator signal. The 300 kHz is divided down to a 100-kHz frequency standard, which is applied to both carrier generators and to the selectable-bandwidth filter. The 300 kHz is also divided down to 50 Hz, which is applied to the multiplier circuit.

The multiplication factor of the multiplier is controlled by the front-panel CENTER FREQUENCY selector, as described later in paragraph 3.2.3. The multiplier provides the center-frequency input, f_{ctr}, to the modulator carrier generator. The modulator carrier generator (described in paragraph 3.2.4) translates f_{ctr} by 100 kHz to 100 kHz + f_{ctr}, and this reference frequency is then applied to the modulator.

Further division of the crystal frequency results in the four center-of-output-range frequencies, 6, 30, 60 and 300 Hz. These are switched selectively into the demodulator carrier generator. The demodulator carrier generator translates the selected center-of-output-range signal (f'_{ctr}) upward to 100 kHz + f'_{ctr}. Then the proper output is automatically switched into the demodulator to provide the carrier frequency. The switching is controlled by a 4-line open/ground signal from the SD301 that reflects the position of the Analyzer ANALYSIS RANGE selector. The demodulator carrier generator is described in paragraph 3.2.5.

3.2.2 Zero I.F. Selectable-Bandwidth Bandpass Filter

Figure 3-4 is a block diagram of the bandpass filter. In the block diagram and throughout the following description, the symbol "±" means "plus and minus". The phase angles, $\angle 0^\circ$ and $\angle 90^\circ$, are relative only; they are not referenced to the input.

The complex data input signal is composed of f_{ctr} (the data component at the center frequency) and f_1 and f_2. The symbol f_1 represents all frequencies greater than f_{ctr} that are within the filter bandpass; f_2 represents all frequencies lower than f_{ctr} that are within the filter bandpass.

The data is mixed in the data balanced modulator with the carrier frequency (100 kHz + f_{ctr}). In the modulating process the carrier frequency is suppressed, leaving the sum, difference, and sidebands as listed in Figure 3-2. This complex signal is applied to both the CO and QUAD zero I.F. balanced demodulators.

The 100-kHz carrier signals applied to the zero I.F. demodulators are displaced by 90 degrees. In the demodulation process, the 100-kHz component is suppressed; the remaining output of both demodulators contains signals $f_1 \pm f_{ctr}$ and $f_{ctr} \pm f_2$ and also a d-c component that is proportional to the original data component at f_{ctr}. Note that because the 100-kHz CO and QUAD carriers are displaced by 90 degrees, the functions of the higher frequency CO signal components ($f_1 \pm f_{ctr}$) phase-lead the corresponding QUAD signal components. Conversely, the functions of the lower frequency CO signal components ($f_{ctr} \pm f_2$) phase-lag the corresponding QUAD signal components. Hence, although $f_1 \pm f_{ctr}$ may be equal to $f_{ctr} \pm f_2$ in frequency, they are not in phase and therefore some frequency information has been transformed into phase information.

The demodulated zero I.F. signals are applied to a buffer amplifier; the gain is approximately 10. The amplifiers are chopper stabilized to minimize any drift due to temperature variations. The amplified signals are then filtered by 6-pole Tchebycheff filters. As described above and shown in Figure 3-4, the CO frequencies of interest ($f_1 - f_{ctr}, \angle 0^\circ$) represent only those frequencies that lie above the center frequency, and the QUAD frequencies of interest ($f_{ctr} - f_2, \angle 0^\circ$) represent those that lie below. Therefore, the cut-off frequency of each variable low-pass filter is only one-half the desired total bandpass. The resistive elements of each filter pole are connected through relays, and the relays operate as a function of the bandwidth switching logic applied to the relay drivers. Thus, the cut-off frequency of the filters is automatically selected to match the ANALYSIS RANGE setting of the Real Time Analyzer.

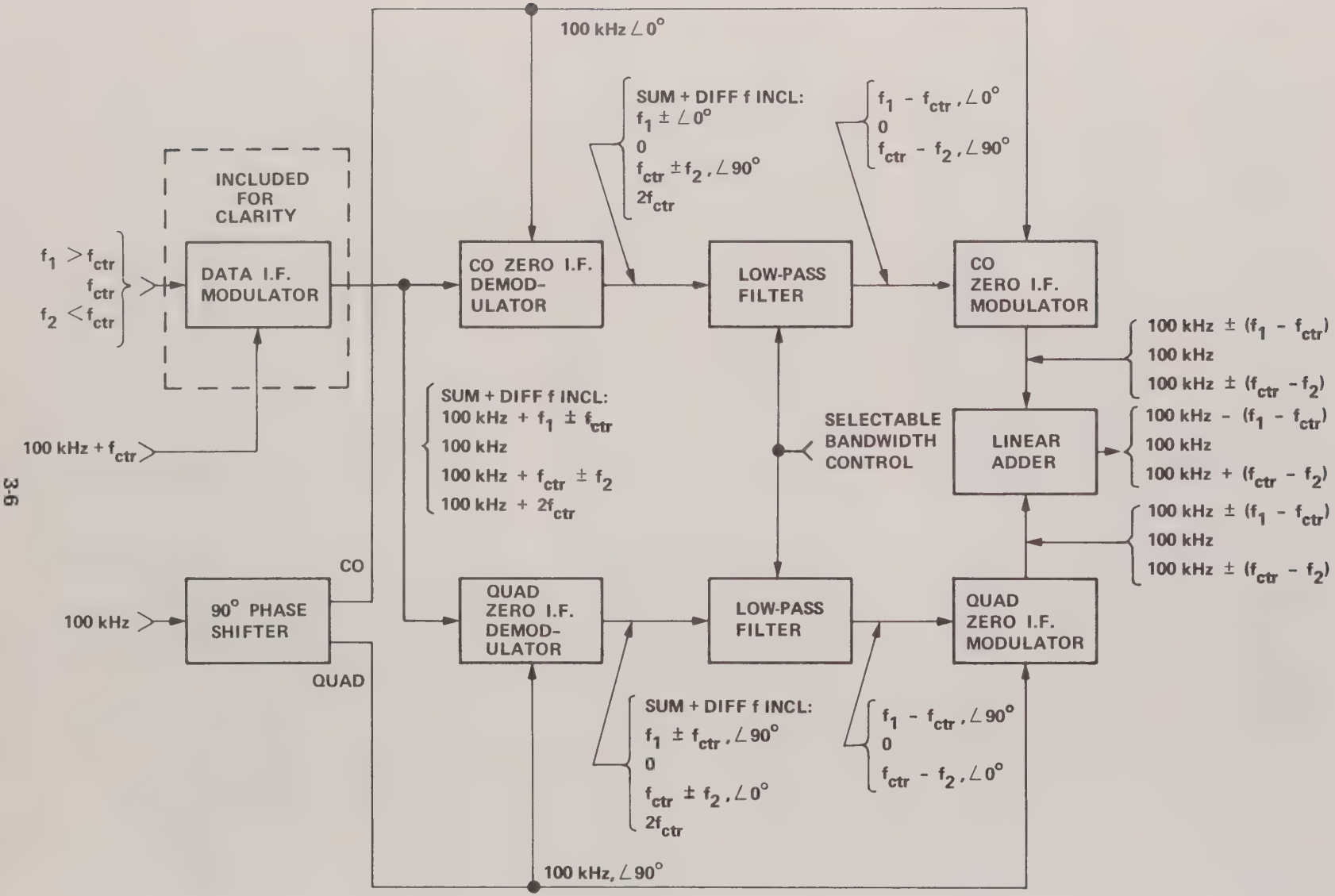


Figure 3-4. Selectable Bandpass Filter — Block Diagram

After filtering, which leaves only the components of data within the filter passband, the CO and QUAD zero I.F. signals are modulated with the 100-kHz CO and QUAD reference signals to restore the 100-kHz I.F. and attendant sidebands. (See Figure 3-4.) When the CO and QUAD 100-kHz I.F. signals are linearly added, the lower CO sidebands, 100 kHz - (f_{ctr} - f_2), and the upper QUAD sidebands, 100 kHz + (f_1 - f_{ctr}), are cancelled. The remaining components, 100 kHz, 100 kHz - (f_1 - f_{ctr}), and 100 kHz + (f_{ctr} - f_2) retain their original frequency spacing; i.e., if f_2 is f_{ctr} - 5 Hz, then 100 kHz + (f_{ctr} - f_2) is 100,005 Hz. A decrease in input frequency causes an increase in output frequency because the lower sideband is taken from the data I.F. modulator. (The demodulator section that follows reverses this effect as it translates the frequency downward.) The relative amplitude and phase of the original signals are also preserved; hence, the output components of the dynamic bandpass filter are amplitude and phase coherent with the input data that lies within the passband.

3.2.3 Phaselock Loop Multiplier

In Figure 3-5, the Phaselock-Loop Multiplier Block Diagram, the signal flow around the loop proper is shown by heavy lines; dashed heavy lines are alternate loop paths. Three sets of frequencies are shown in differently styled brackets; each is an example of operation at the CENTER FREQUENCY setting shown in the correspondingly styled brackets. Frequencies shown without brackets are generalized as functions of m, the CENTER FREQUENCY setting. In the Block Diagram description, f_{ctr} is the center frequency, whereas m is the CENTER FREQUENCY setting; the two are numerically equal.

The multiplier is principally a phaselock loop that incorporates a selectable divider. Referring to Figure 3-5, note that the selectable divider consists of a BCD encoder on which the center frequency is set manually, a BCD register that counts the VCO output pulses, and a comparator that compares the contents of the BCD register to that of the manual BCD encoder. When the contents of the BCD register and the BCD encoder coincide, the comparator produces an output pulse that resets the BCD register. Hence, the frequency of this reset pulse is the VCO frequency divided by m, which should be 50 Hz as will be explained.

This reset-pulse signal is applied to the frequency-phase detector. If the VCO frequency is not m times the 50 Hz input frequency, then the comparator output is not 50 Hz, and the detector produces an error signal. The error signal is integrated and used to correct the VCO frequency. Thus, the VCO frequency is always m times 50 Hz.

To limit the VCO frequency range, the frequency dividers are automatically switched into the loop. They provide no VCO frequency division if the third and fourth decades of the CENTER FREQUENCY selector are set to zero; however, they divide by 10 if the fourth but not the third

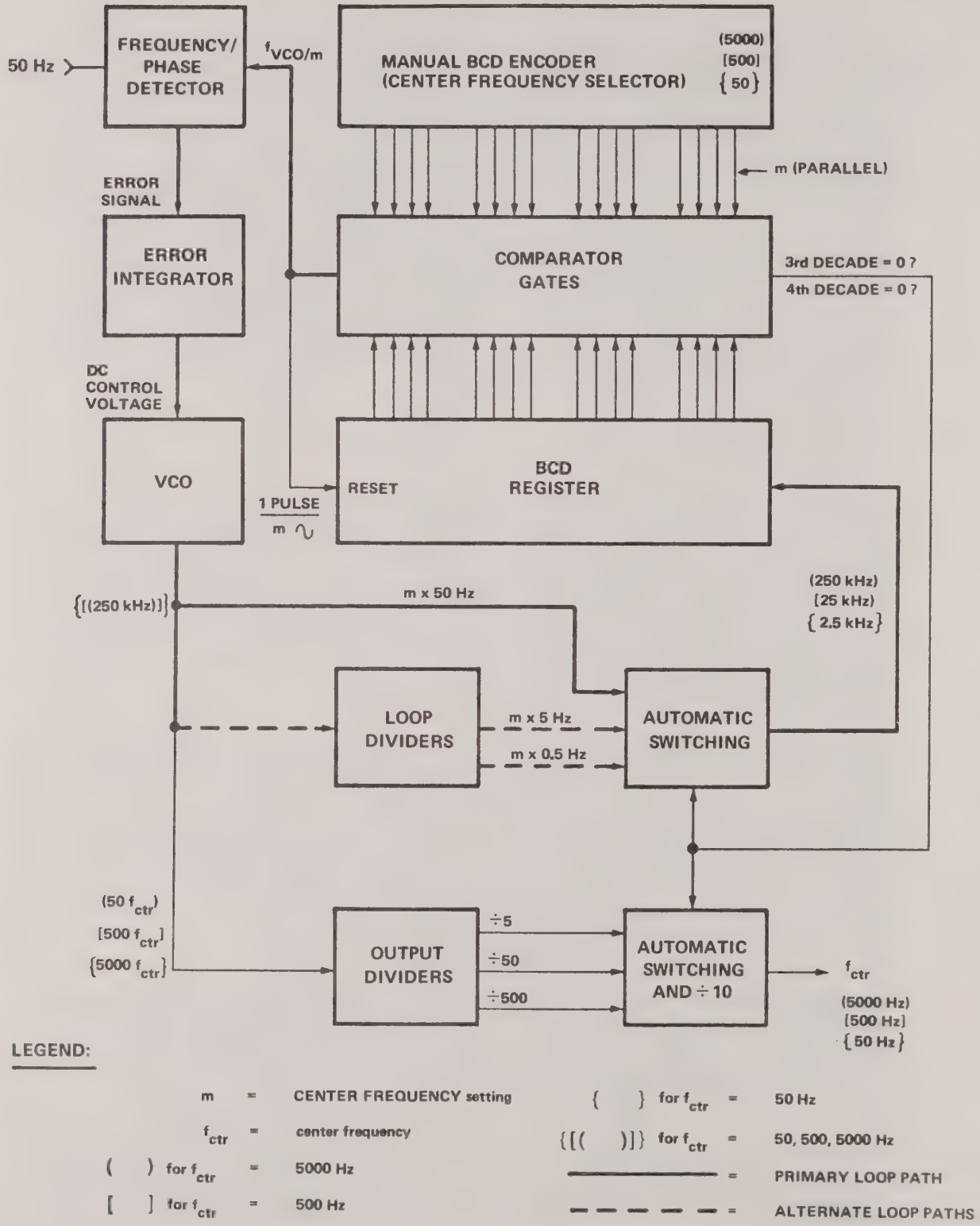


Figure 3-5. Phaselock-Loop Multiplier Block Diagram

decade is zero, and by 100 if neither is zero. Referring to the frequencies given as examples on the Block Diagram, note that the VCO operates over a single decade for all of the three highest decades of the center frequency.

The output dividers switch in synchronism with the loop dividers, and they restore the VCO frequency to the proper decade, while they simultaneously divide out the original 50 Hz loop input frequency. Hence, the multiplier output frequency (f_{ctr}) is equal to the setting (m) on the manual BCD encoder.

3.2.4 Modulator Carrier Generator

The modulator carrier generator converts the center frequency, f_{ctr}, into the reference frequency, f_r = 100 kHz + f_{ctr}. The circuit is basically a phaselock loop translator. The main elements and signal path of the phaselock loop are shown in the Block Diagram, Figure 3-6, in bold lines.

The balanced demodulator and the low-pass filter are the elements within the loop that cause it to translate. Note that the carrier input to the demodulator is the output of the loop. The 100 kHz clock frequency is also applied. The demodulator output is the upper and lower sidebands; the carrier frequency is suppressed. The low-pass filter removes the upper sideband. If the VCO frequency is correct (100 kHz + f_{ctr}), the output of the low-pass filter is f_{ctr}, which is the loop input frequency.

The frequency/phase detector compares this frequency to the actual input-signal frequency. If the VCO frequency is not 100 kHz + f_{ctr}, then the filter output is not f_{ctr}, and the detector produces an error signal. The error signal is integrated and used to correct the VCO frequency. Thus the VCO frequency is held to f_r = 100 kHz + f_{ctr}.

The recovery time control speeds up the loop time constant by a factor of five when the loop is out of lock and/or the frequency of f_{ctr} is less than approximately 100 Hz. The out-of-lock condition occurs momentarily with a step change in loop input, such as occurs when switching the CENTER FREQUENCY selector.

When the recovery-time control senses the above conditions, it operates a FET switch. The switch is in series with an impedance that shunts the integrator input when the switch closes, thereby decreasing the loop gain. As a result, the loop retains a longer time constant when operating normally, but recovers quickly when out of lock.

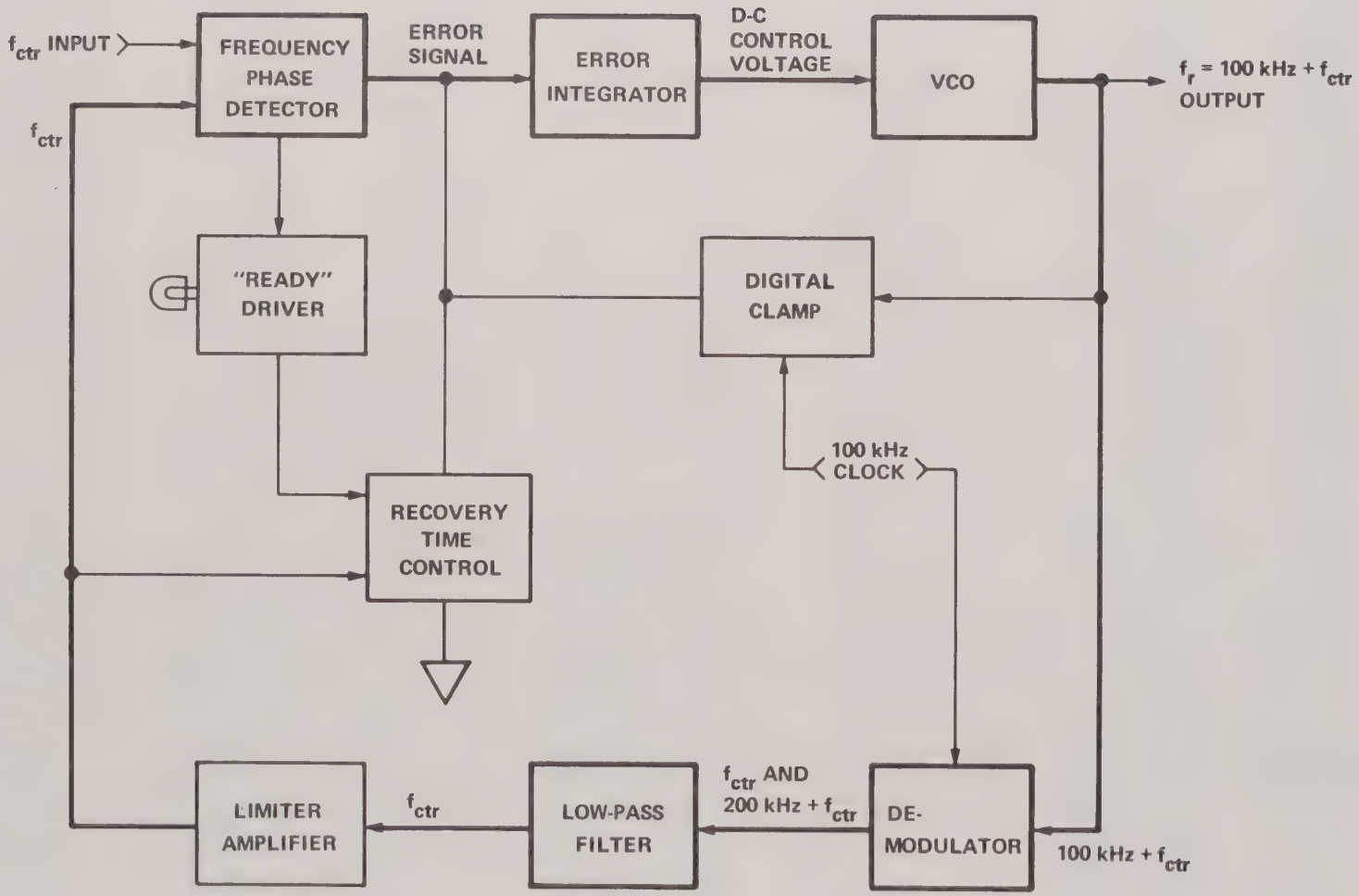


Figure 3-6. Modulator Carrier Generator — Block Diagram

The translation loop will not correct for VCO frequencies below the 100-kHz clock frequency; therefore the digital clamp circuit is included. If the VCO-output frequency falls below the clock-signal frequency, the digital-clamp output signal overrides the frequency/phase detector error signal and corrects the VCO frequency upward.

3.2.5 Demodulator Carrier Generator and Bandwidth Switching

A separate local oscillator supplies the center frequency reference (f'_r = 100 kHz + f'_{ctr}) for each of the four output bandwidths. These oscillators are contained in the demodulator carrier generator. In order to hold the frequency of the local oscillators to within close tolerances, they are included in a phaselock loop. The loop operates as follows. (Refer to Figure 3-7.)

The bandwidth-switching circuits select a center frequency (divided down from the 300 kHz master clock) to be the input of the loop, and they also select the corresponding local oscillator (VCXO). For this explanation it is assumed that the center frequency chosen is 6 Hz, and therefore the output of the 100,006 Hz VCXO is selected.

The 100,006 Hz is applied to the loop demodulator as a carrier frequency, and the 100 kHz clock frequency (divided down from the 300 kHz master clock) is also applied. The demodulator output is the upper and lower sidebands; the carrier is suppressed. The low-pass filter removes the upper sideband. If the VCXO frequency is correct (6 Hz greater than the 100 kHz clock), the output of the low-pass filter if 6 Hz, which is the loop input frequency.

The frequency/phase detector compares the frequency to the actual input-signal frequency. If the VCXO frequency is not 6-Hz greater than the clock frequency, then the filter output is not 6 Hz, and the detector produces an error signal. The error signal is integrated and used to correct the VCXO frequency. Any frequency error in the VCXO with respect to the 100 kHz clock is due solely to the 6 Hz loop input, which is derived from the clock. But this is only 0.001% of the error in the clock itself. Thus there is effectively no error in the data-demodulator carrier frequency with respect to the 100 kHz clock frequency.

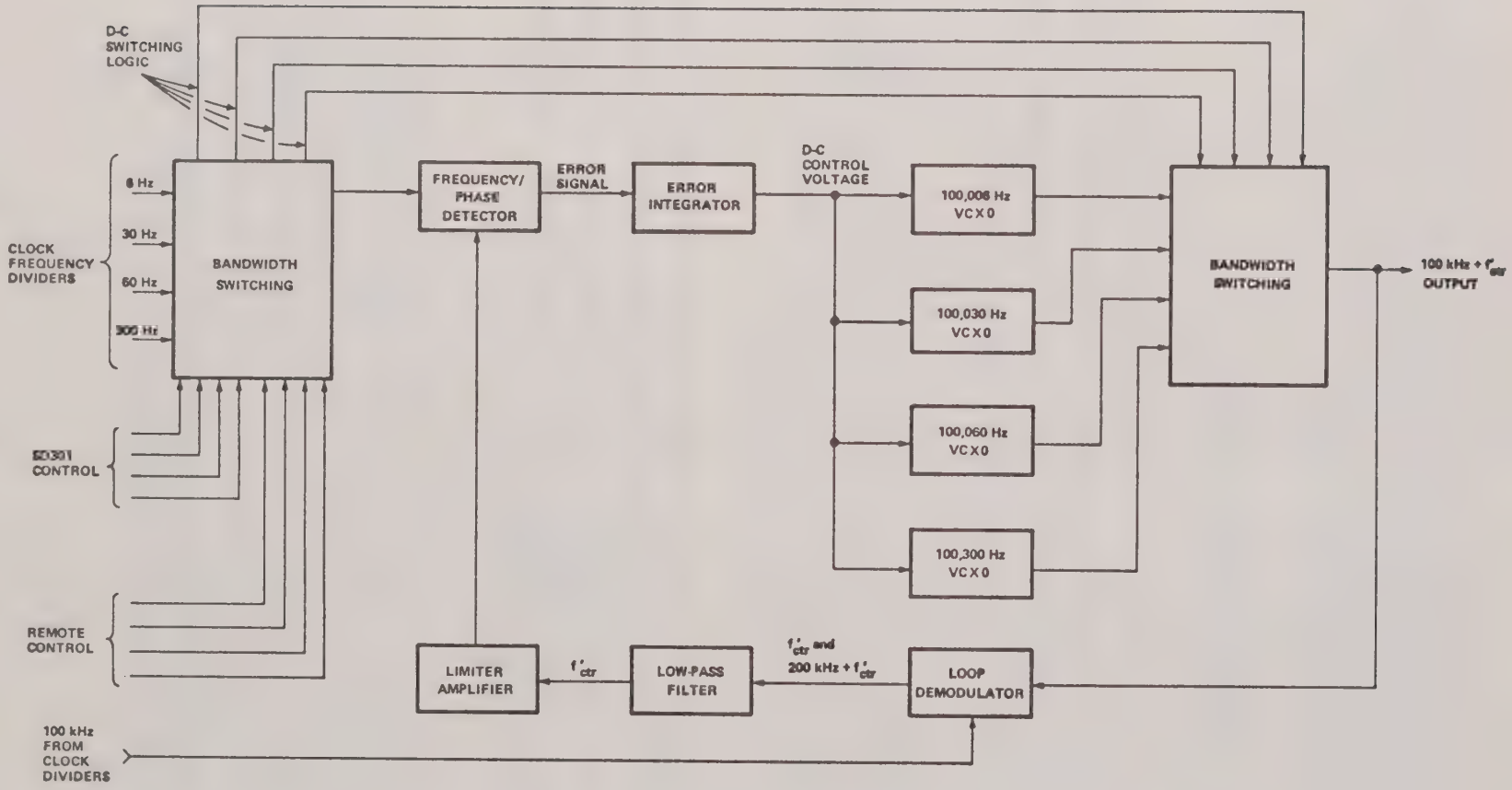


Figure 3-7. Demodulator Carrier Generator Block Diagram

SECTION IV

CALIBRATION

4.1 GENERAL

Before calibrating the instrument, the technician should study the previous sections of this manual, especially Section II, Operation. Refer to Section I, paragraphs 1.2 and 1.3, for functional descriptions of the controls, indicators and connectors. It is important that Section III, Concept and Theory of Operation, be understood fully before troubleshooting or attempting repair.

Figure 4-1 is a top-chassis view with the cover removed, showing the calibration controls. Figure 4-2, the Model 13105 Functional Block Diagram (back of manual in drawings section), shows all of the calibration controls and all of the test points referred to in paragraph 4.2, Calibration Procedure.

Test points and components mounted on circuit cards are referenced by an alphanumeric designator that identifies the circuit card as well as the component. For example, on circuit card A1 resistor R23 is referred to as A1R23. Circuit card pin connections are referenced by the circuit card designator, hyphen, pin number or letter; such as A11-7 or A11-S.

Circuit cards are keyed to their respective receptacles by slots cut between contacts. These slots mate with corresponding "keys" in the receptacles. The extender card is slotted between every contact, so that it fits into any receptacle.

Access to calibration controls and test points is facilitated by use of the extender card. Before extending a circuit card, remove power from the instrument. Then remove the circuit card, plug the extender card *→ in its place and plug the circuit card into the receptacle mounted on the extender card. Reapply power to the instrument only after the circuit card is installed on the extender card. When not in use the extender card is installed in card position A13.

Throughout the calibration procedure, it is assumed that proper operation of the SD301A or B Analyzer is understood, and minimum reference is made to that instrument.

4.2 CALIBRATION PROCEDURE

To ensure proper calibration, perform the following procedure in its entirety and in the sequence given. All measurements and adjustments are performed with all circuit cards installed.

Table 4-1 lists the test equipment required. Instruments with equal or better performance characteristics may be substituted.

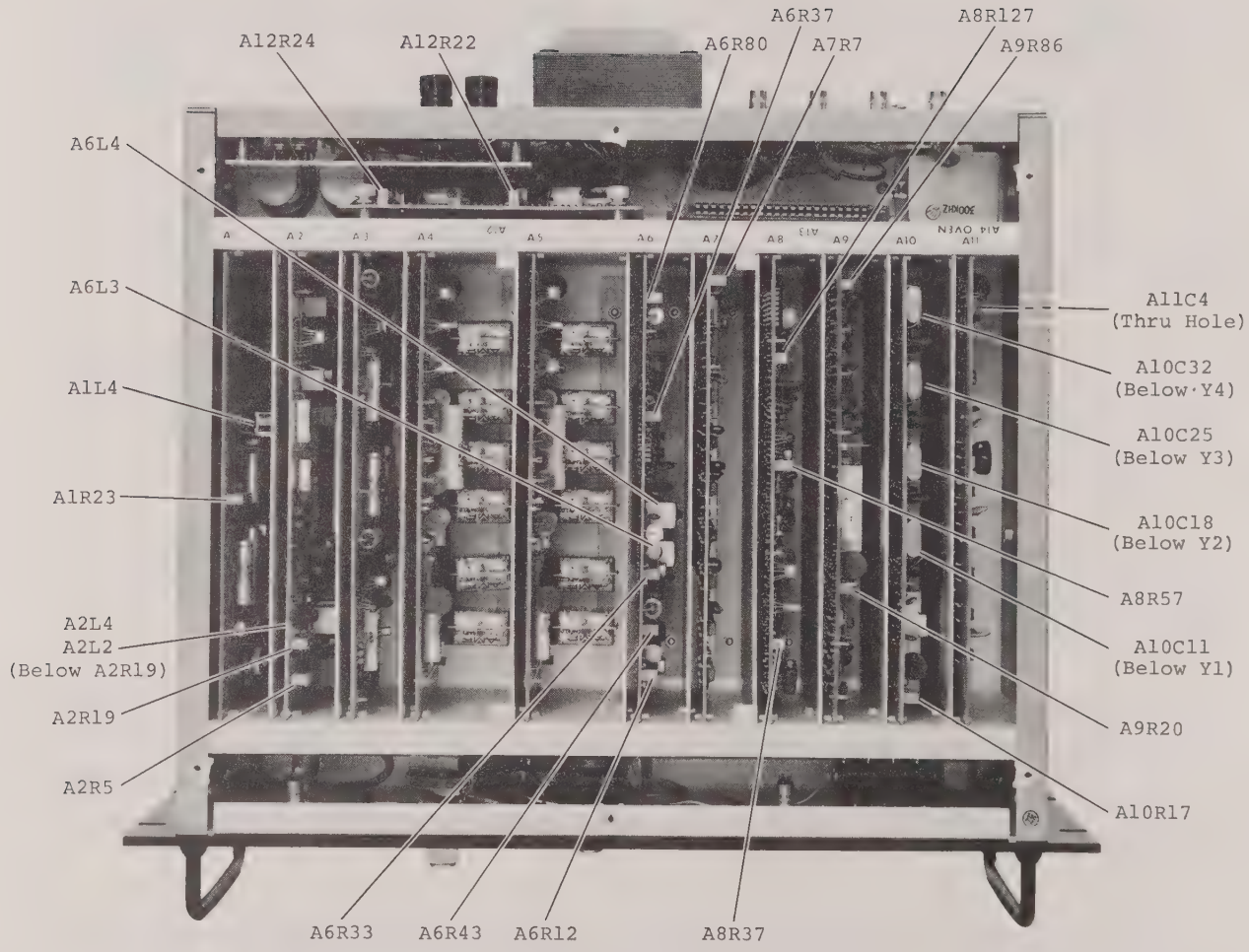


Figure 4-1. Chassis Top View — Calibration Controls

TROUBLESHOOTING ON EASY ST.

PANIC THOUGHTS

- I've never seen this one before!
- Does anybody know how it happened?
- They probably need it fixed yesterday!
- Who can I ask for help?

POSITIVE APPROACH

- Problem is probably simple.
- I can fix this problem easily.
- I am going to think logically.
- I am going to carefully evaluate the front panel indications.
- I'll talk to the person who had the problem.

READY

- I can whip the problem NOW.

SUCCESSIVE HALF-SPLIT TROUBLESHOOTING METHOD

ONE QUARTER

ONE EIGHTH

ONE SIXTEENTH

"ONE FOUND"

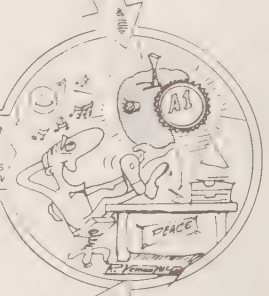
ONE HALF

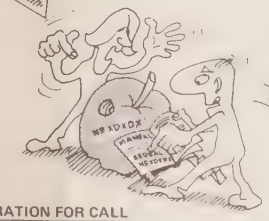
- Evaluate front panel symptoms before removing cover.
- Look for obvious—simple problem.
- Do not adjust to "FIX" problems!

- Have spare parts or circuit card?
- Check & Double-check; then order parts.
- Prepare for call: Have correct part number from part or schematic. Have complete Model and Serial Numbers from rear of chassis.

The SDC Customer Service Team is At Your Service Aiming To Please

SERVICE IS OUR BUSINESS



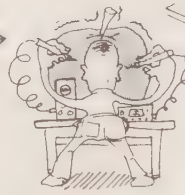


PREPARATION FOR CALL

- Have talked to person who experienced the problem.
- Have read the manual.
- Have complete Model and Serial Numbers from rear of chassis.

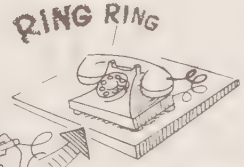
YOU CALL FOR INSTRUCTIONS

- We spell out tests.



YOU PERFORM CHECKOUT

- As instructed



WE CALL BACK

- To Check & Double-check

Table 4-1. Test Equipment Required

Name	Model Number	Manufacturer
Digital Voltmeter	3440A	Hewlett-Packard
Oscilloscope	561	Tektronix
Plug-in Unit	2A63	Tektronix
Frequency Counter	1191*	General Radio
Real Time Analyzer	SD301A or B	Spectral Dynamics
Sweep Generator	SD104A-5	Spectral Dynamics
RMS Voltmeter	3400A	Hewlett-Packard

*The GR1191 Frequency Counter is available with several options. Only those that incorporate the temperature stabilized frequency standard are acceptable. This option is provided in General Radio catalog numbers 1191-9714 through 1191-9717.

4.2.1 Preliminary Setup – Power Off

a. Check that the 115/230 switch on the instrument rear chassis is set to the correct primary power source voltage.

b. Check the F1 fuse receptacle for a fuse of proper rating; it should be a 2A SLO-BLO.

c. Check the F2 fuse receptacle for a properly rated fuse; 2A SLO BLO for 115 Vac operation and 1A SLO BLO for 230 Vac operation.

d. Connect power cord to primary power source. Depress the power switch/indicator; it should light indicating that power is applied to the circuitry.

4.2.2 Power Supply (A12)

*→ a. Connect a DVM to A12TP2. Adjust A12R24 for –15 Vdc (–14.99 to –15.01 Vdc).

b. Connect a DVM to A12TP1. Adjust A12R22 for 15 Vdc (14.99 to 15.01 Vdc).

4.2.3 Master Clock System (A11)

Setup:

- Connect cable assembly 13258-1 between SD301 J14 and Model 13105 J5.
- Connect coaxial cable between SD301 J24 (or front-panel SIGNAL INPUT connector) and Model 13105 J4.
- Model 13105

MODE	CAL
RANGE	0 dB
CENTER FREQUENCY	1000

SD301

INPUT RANGE	.1
ANALYSIS RANGE	500

NOTES

1) Allow 1/2 hour warm-up time before performing step a., below.

2) Adjustment of A11C4 must be made with card A11 not extended.

a. Connect frequency counter to A11TP1. Adjust A11C4 for 300 kHz (299.999 to 300.001 kHz).

4.2.4 Local Oscillators (A10)

Setup: • Set the SD301B ANALYSIS RANGE to UPPER LIMIT 500.

• Remove power. Extend A10, and reapply power.

a. Connect oscilloscope to A10TP4. Adjust A10R17 until both positive and negative narrow pulses are obtained.

b. Connect frequency counter to A10TP10 and DVM to A10TP5. Check for 100,300 Hz and adjust A10C32 for 4.2 Vdc (4.1 to 4.3 Vdc).

c. Set SD301B ANALYSIS RANGE to UPPER LIMIT 100. Check for 100,060 Hz and adjust A10C25 for 4.2 Vdc (4.1 to 4.3 Vdc).

d. Set SD301B ANALYSIS RANGE to UPPER LIMIT 50. Check for 100,030 Hz and adjust A10C18 for 4.2 Vdc (4.1 to 4.3 Vdc).

e. Set SD301B ANALYSIS RANGE to UPPER LIMIT 10. Check for 100,006 Hz and adjust A10C11 for 4.2 Vdc (4.1 to 4.3 Vdc).

4.2.5 Local Oscillator Control (A9)

Setup: Remove power. Reinstall A10, extend A9, and reapply power.

a. Connect oscilloscope to A9TP17. Adjust A9R86 for minimum 100-kHz component. (Use highest possible oscilloscope gain and observe top of waveform.)

4.2.6 Multiplier (A7, A9)

a. Connect oscilloscope to A9TP6, and adjust A9R20 for narrowest pulse obtainable. (Waveform should be going between positive and negative pulses.)

Setup: Remove power. Reinstall A9, extend A7, and reapply power.

b. Set Model 13105 to CAL and CENTER FREQUENCY to 1000. Connect oscilloscope to A7TP10 (next to R7). Adjust A7R7 for ≈200 mV square wave. (Not critical, will be calibrated later in procedure.

4.2.7 Translation Loop (A8)

Setup: • ANALYSIS RANGE to 500.

• Remove power. Reinstall A7, extend A8, and reapply power.

a. Set CENTER FREQUENCY to 9999. Connect DVM to A8TP8, and adjust A8R57 for 10 Vdc, ±0.1V (9.9V to 10.1V).

b. Set the CENTER FREQUENCY to 1000. Connect oscilloscope to A8TP16, and adjust A8R127 for minimum 100-kHz component.

c. Connect oscilloscope to A8TP7. Adjust A8R37 for narrowest possible, 0 to 0.2V, negative-going pulse.

4.2.8 Input (A1)

Setup: • Remove power. Reinstall A8, extend A1, and reapply power.

• Center Model 13105 CAL potentiometer.

• Set MODE to OPER.

a. Set Model 13105 MODE to OPER and RANGE to 0.1V. Apply 1000 Hz at 0.1 Vrms. With oscilloscope, monitor A1TP6 and TP7, and adjust A1R23 for most symmetrical waveform at ≈0.82V p-p at both TPs.

4.2.9 I.F. MOD (A2)

Setup: Remove power. Reinstall A1, extend A2, and reapply power.

a. Connect oscilloscope to A2TP1. Adjust A2L2 and A2L4 for peak signal amplitude.

b. Connect oscilloscope to A2TP2. Adjust A2R5 for 7V p-p clean sine wave.

4.2.10 F.S.O. (A6)

Setup: • Remove power. Reinstall A2, extend A6, and reapply power.

• Lift input (E1) end of A6C15. Connect oscillator to input end of A6C15, and apply a 100,000 kHz sine wave. Connect RMS meter to A6TP6. Adjust amplitude of oscillator for 0.1 Vrms.

a. Readjust oscillator frequency for 92,000 Hz, and adjust A6L3 to peak signal amplitude at A6TP7.

b. Again readjust oscillator frequency to 108,000 Hz, and adjust A6L4 to peak signal amplitude at A6TP7.

c. Repeat steps a. and b.

d. Reconnect A6C15.

Setup: • Model 13105

No cards extended. Apply a 850 Hz full scale sine input (0.1 Vrms) to J1. Set controls as follows:

MODE	ZERO
RANGE	0 dB
CENTER FREQUENCY	1000 Hz

• SD301B

Connect SD301 SPECTRUM LOG output to display unit vertical input and FREQUENCY LIN output to horizontal input. Set controls as follows:

CAL MODE	OPER
OUTPUT GAIN	X1
MEMORY PERIOD	AUTO
MODE	SCOPE FAST
ANALYSIS RANGE	UPPER LIMIT 500
INPUT RANGE	0 dB
MEMORY	UPDATE

e. Adjust A6R12 and A6R33 until spurious pip at center of spectrum display disappears.

f. Set Model 13105 MODE to CAL and CENTER FREQUENCY to 3500. Adjust A9R20 to minimize 50 Hz sidebands. This adjustment sets the error pulses to the multiplier error integrator for the narrowest possible pulse width. The pulses can be observed on A9TP6.

g. Set Model 13105 MODE to OPERATE and CENTER FREQUENCY to 1000 Hz. Input should still be at 850 Hz.

- Adjust A2R19 and A6R43 to minimize +150 Hz sideband (-46 dB or less). This adjustment sets the 90° phase difference and the Zero I.F. summing of the CO and QUAD channels.

- Step SD301 ANALYSIS RANGE to UPPER LIMIT 100. Change J1 input signal frequency to 970 Hz. Check that +30-Hz sideband is -46 dB or less.

- Step SD301 ANALYSIS RANGE to UPPER LIMIT 50. Change J1 input signal frequency to 985 Hz. Check that +15-Hz sideband is -46 dB or less.

- Step SD301 ANALYSIS RANGE to UPPER LIMIT 10. Change J1 input signal frequency to 997 Hz. Check that +3-Hz sideband is -46 dB or less.

h. Apply a 0.1 Vrms sine wave at 850 Hz to J1. Set CENTER FREQUENCY selector at 1000 Hz and SD301 ANALYSIS RANGE to UPPER LIMIT 500. Check the center frequency component rejection. Should be at least -50 dB. If necessary, alternate between ZERO and OPER MODE setting, readjusting A6R12 and A6R33 each time to obtain a compromise adjustment for minimum center frequency component.

i. Connect oscilloscope to A6TP9. Adjust A6R37 for minimum high-frequency modulator-unbalance signal (approximately 100 kHz).

j. Center CAL pot on front panel and apply a 1 kHz sine wave at 0.1 Vrms to Model 13105 input jack. Connect rms meter to J4 on rear of Model 13105 chassis, and adjust A6R80 *→ for 0.316 Vrms. Check with oscilloscope for an approximate sine wave; some high frequency noise is normal.

*→ k. Set Model 13105 Mode to CAL. Adjust A7R7 for 0.316 Vrms output at J4.

4.2.11 Final Adjustments

a. Set Model 13105 MODE to ZERO, with no circuit cards extended. If necessary, adjust A6R12 and A6R33 until spurious pip at center of spectrum display is gone. Again check in OPERATE, with data signal at full scale, by sweeping input frequency from 750 to 1250 Hz; spurious pips should be below -40 dB from 800 to 1200 Hz.

b. Set Model 13105 MODE to CAL and SD301 to 500 Hz bandwidth. Adjust A9R20 to minimize 50-Hz sidebands.

c. Set Model 13105 MODE to OPERATE and CENTER FREQUENCY to 1000. Apply 850 Hz to J1. Readjust A2R19 and A6R43 to minimize sidebands.

4.3 PARTS REPLACEMENT

Except for some special SDC specification-controlled parts listed in Table 4-2, which must be ordered from Spectral Dynamics Corporation, standard electronic parts have been used throughout the instrument. Spectral Dynamics Corporation maintains a complete stock of all parts and complete printed circuit card assemblies used in the instrument.

When ordering a replacement part or assembly, be sure to include the reference designation, the part number or manufacturer's designation, and a complete description; include also the instrument name, model number, and serial number.

Table 4-2. Special Replaceable Parts List

Reference Designator	Description	Part Number Mfr. Designation
A1	Circuit Card, INPUT	12956-1
A2	Circuit Card, I.F. MOD	12958-1
A3	Circuit Card, ZERO I.F./X10 AMP	12960-1
A4,A5	Circuit Card, Low Pass Filter	12952-1
A6	Circuit Card, FSO	12962-1
A7	Circuit Card, MULTIPLIER NO. 2	12964-1
A8	Circuit Card, TRANSLATION LOOP	12966-1
	(Cont'd)	

Table 4-2. Special Replaceable Parts List (Cont'd)

Reference Designator	Description	Part Number Mfr. Designation
A9	Circuit Card, MULTIPLIER No. 1/L. O. Control	13494-1
A10	Circuit Card, LOCAL OSCILLATORS	12968-1
A11	Circuit Card, MASTER CLOCK SYSTEM	12970-1
A12	Circuit Card, POWER SUPPLY	13262-1
A13	Circuit Card, EXTENDER	12950-1
A14	Crystal Oven	20013-112
A14Y1	Crystal, 300-kHz	20013-343
	Knob	20013-174
	Knob (2)	20013-175
S2	Switch, INPUT RANGE	20013-322
S3	Switch, INPUT RANGE dB	20013-324
S4	Switch, MODE	20013-137
S5	Switch, CENTER FREQUENCY	20013-317
T1	Transformer, power	20013-359
DS1	Lamp	CFO3-ACS-2102
DS2	Lamp, POWER	A1H
DS3, DS4	Lamp	CFO3-WTS-2102
A1L1	Coil, 2.70 mH 1%	20013-182
A1L2	Coil, 6.25 mH 1%	20013-181

(Cont'd)

Table 4-2. Special Replaceable Parts List (Cont'd)

	Reference Designator	Description	Part Number Mfr. Designation
	A1L3	Coil, 6.39 mH 1%	20013-180
	A3Q6, A3Q12	Transistor, μC714	20013-243
	A4C2, A5C2	Capacitor, 0.5994 μF, 100V, 1%	20013-351-9
	A4C3, A5C3	Capacitor, 0.4260 μF, 100V, 1%	20013-351-8
	A4C12, A5C12	Capacitor, 0.7071 μF, 100V, 1%	20013-351-10
	A4C13, A5C13	Capacitor, 0.1264 μF, 100V, 1%	20013-351-7
	A4C18, A5C18	Capacitor, 1.058 μF, 100V, 1%	20013-351-11
	A4C19, A5C19	Capacitor, 0.04402 μF, 100V, 1%	20013-351-5
	A4C24, A5C24	Capacitor, 3.013 μF, 100V, 1%	20013-351-12
	A4C25, A5C25	Capacitor, 0.01155 μF, 100V, 1%	20013-351-2
	A8L1	Coil, 615 mH 1%	20013-159
	A10Y1	Crystal, 100,006 Hz	20013-346-1
	A10Y2	Crystal, 100,030 Hz	20013-346-2
	A10Y3	Crystal, 100,060 Hz	20013-346-3
	A10Y4	Crystal, 100,300 Hz	20013-346-5
		Power Cord	Belden 17258-S
*→	A4K1–6 A5K1–6	Relay	R10-E1-Z4-J25K
	A11K1	Relay	712-5

*Revised (4-19-71)

APPENDIX

Translator Operation to 99 kHz

In order to prevent data input signals at the I.F. frequency (100 kHz) or above from passing through the data I.F. modulator, where they would produce false images, the Translator input circuit has a 6-pole Tchebycheff low-pass filter which cuts off above 50 kHz, providing a minimum of 40 dB attenuation at 100 kHz and above. The fully balanced monolithic modulator provides a minimum of 40 dB rejection of data input frequencies when properly balanced. The total 100 kHz rejection is greater than 80 dB.

The low-pass filter limits the high frequency operation of the Translator to 50 kHz, but it may be operated to 99 kHz by bypassing the filter and using an external synthesizer.

To bypass the filter, remove or disconnect the components, A1L1, A1L3, and A1C9, and insert a jumper across the filter, as shown in Figures 1 and 2. Be sure that the instrument is properly calibrated before beginning the modification.

After making the modification, rebalance the data I.F. modulator for maximum data attenuation (greater than 40 dB) as follows:

a. Interconnect Translator, RTA, and Display units as described in Section II.

b. Apply a full-scale 100-kHz data signal to J1.

c. Setup:
- INPUT RANGE (coarse) to 0 dB
- INPUT RANGE (fine) to 0 dB
- MODE to OPER
- CENTER FREQUENCY to 0250
- MULTIPLIER to X1
- [RTA] ANALYSIS RANGE to UPPER LIMIT 500

d. Observe any spurious component appearing in the middle of the display. Determine the proper "spur" by varying the 100-kHz data signal by ±100 Hz.

e. Adjust A1R23 in the Translator for minimum amplitude of "spur".

NOTE

To select a data-window center frequency above 49 kHz, an external frequency synthesizer must be used, as described in Paragraph 2.4.3.

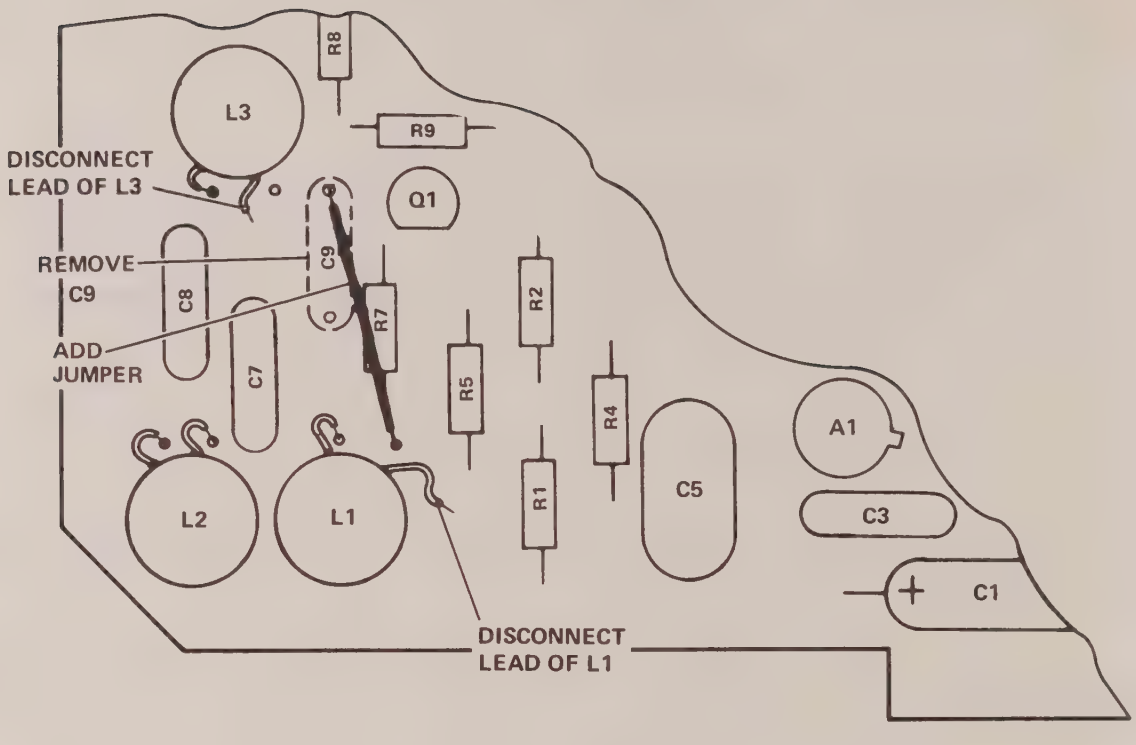


Figure 1. Component Layout
Input Circuit Card A1 Modification

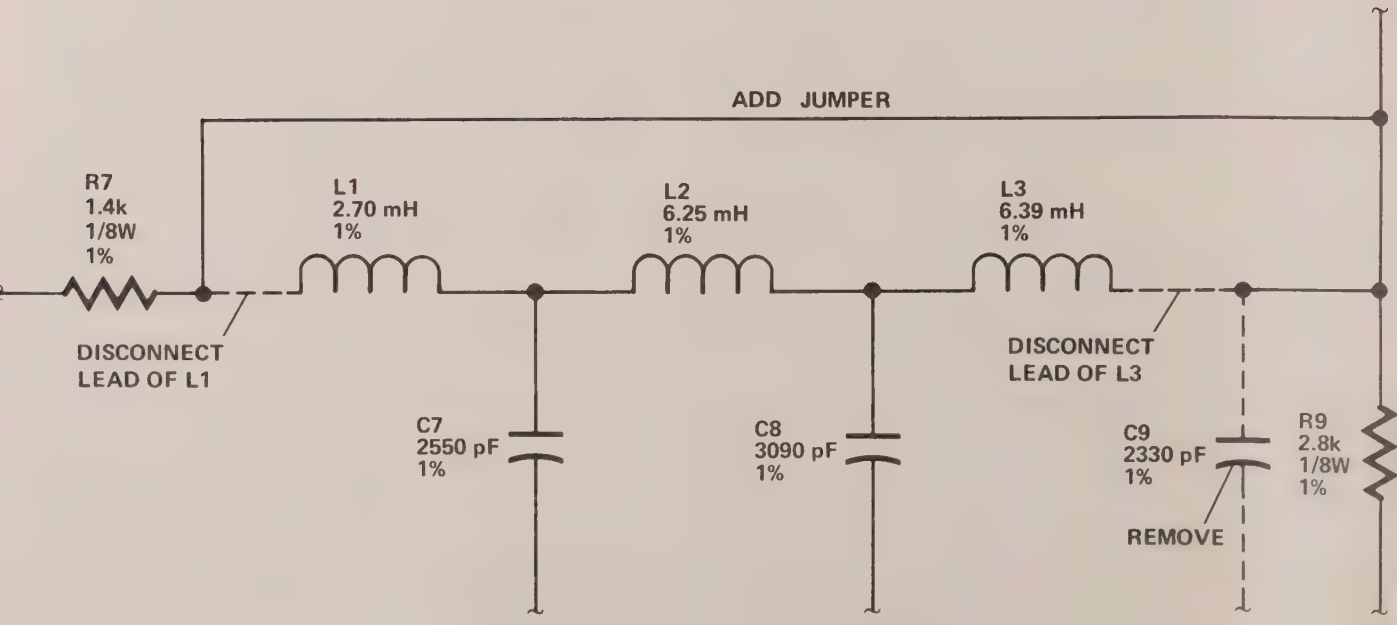
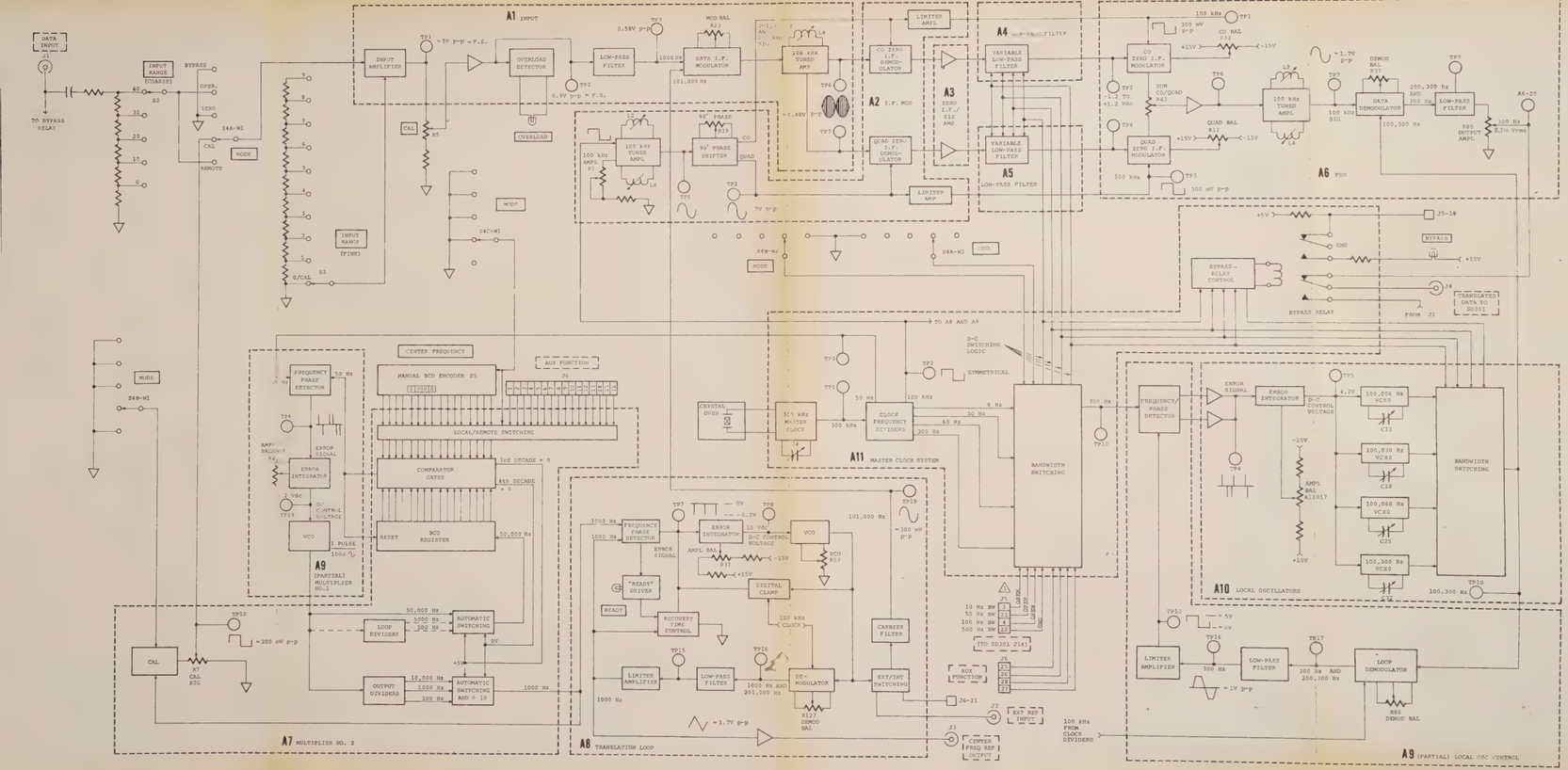


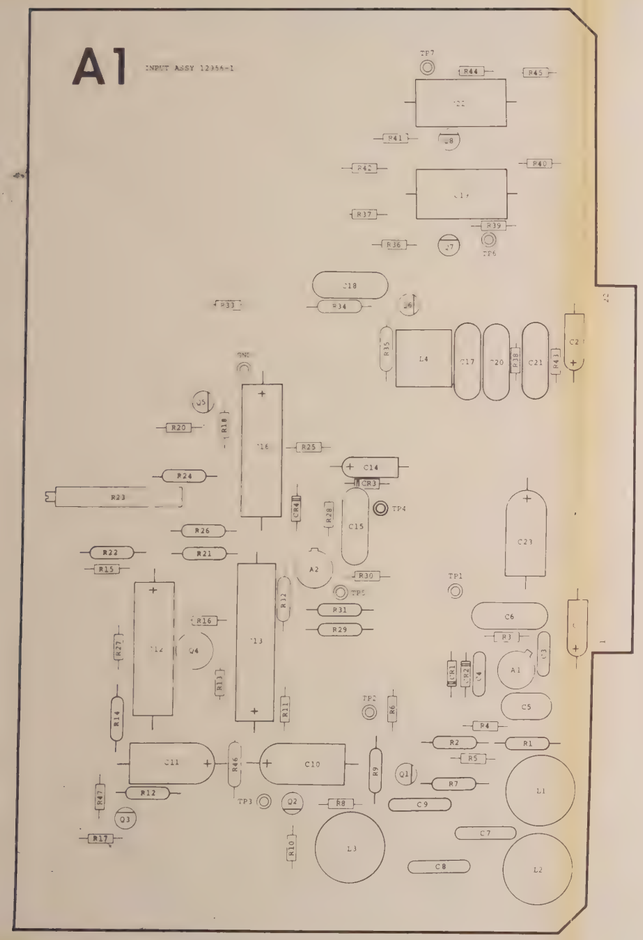
Figure 2. Schematic
Input Circuit Card A1 Modification

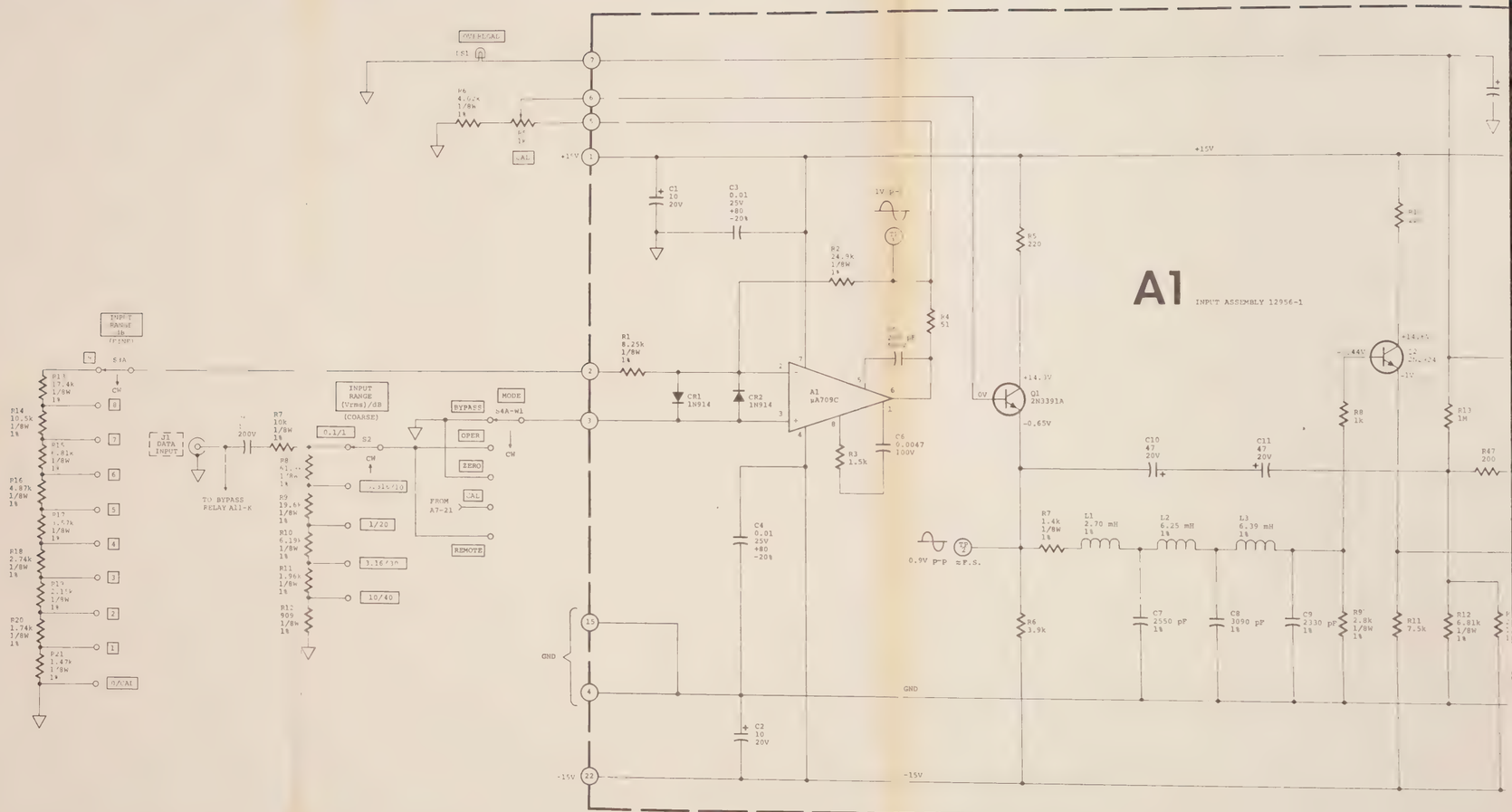


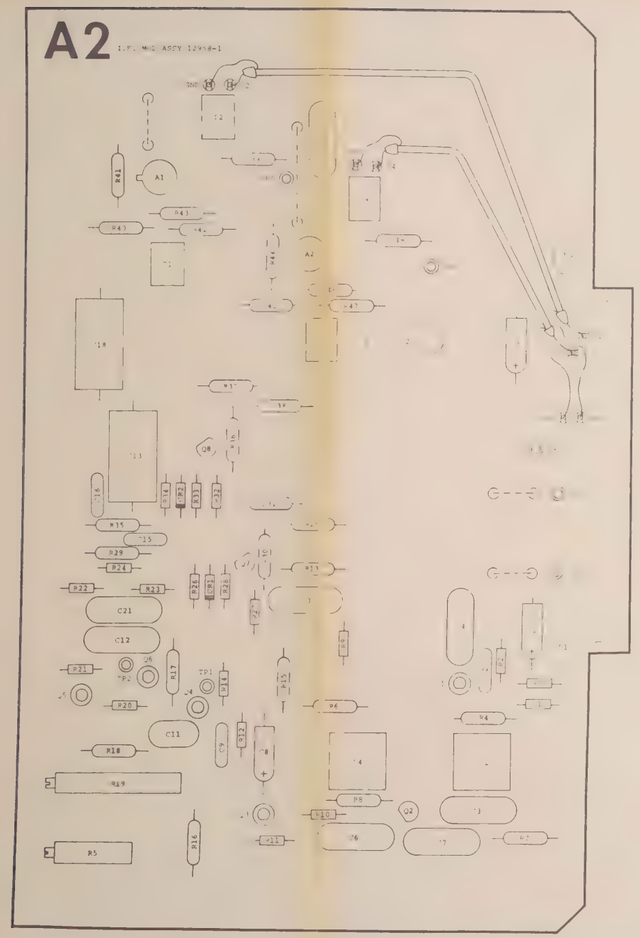
NOTES:

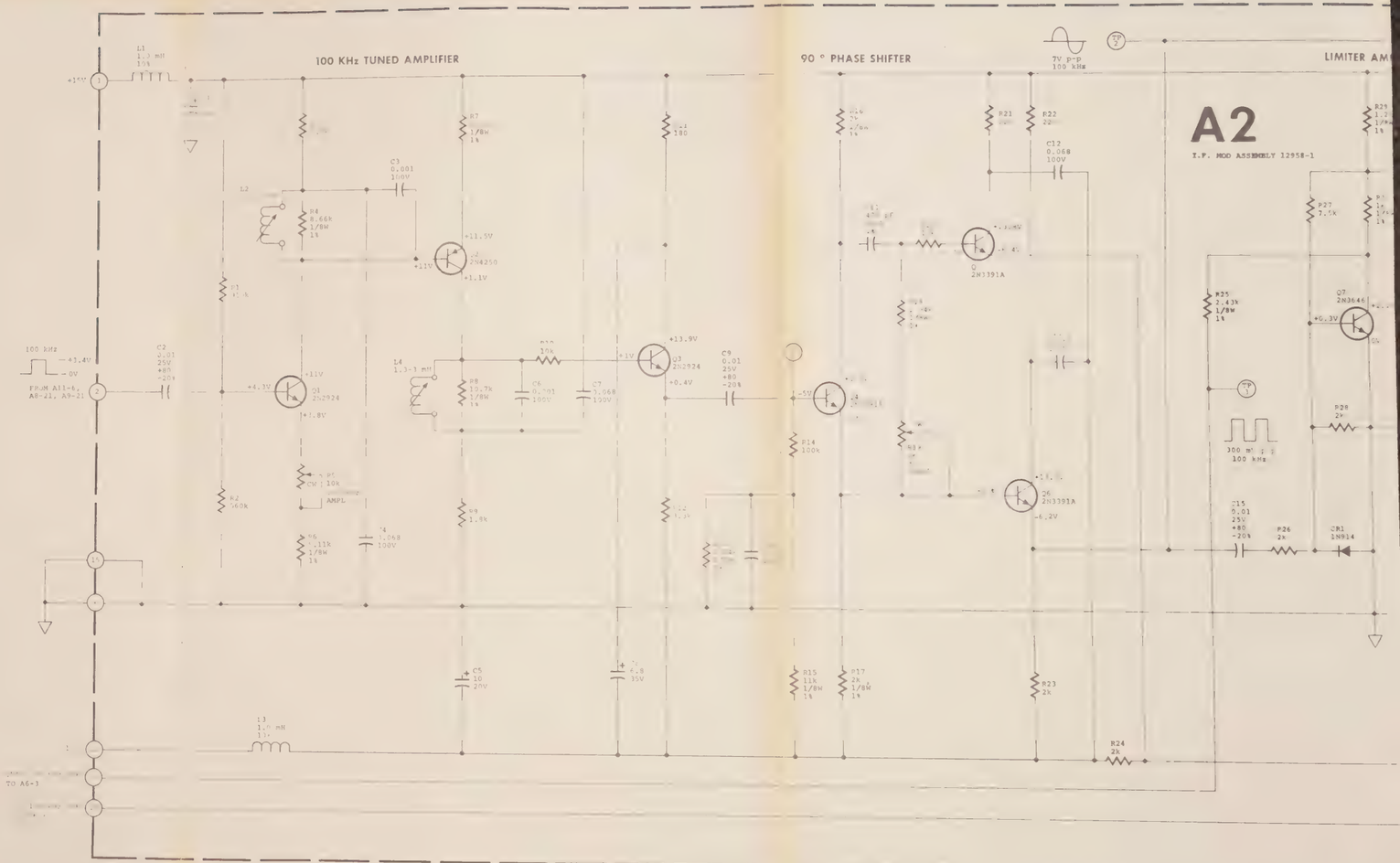
1. ALL FREQUENCIES AND VOLTAGES GIVEN ARE FOR THE FOLLOWING SETUP:
   - INPUT RANGE TO 0/CAL
   - MODE TO CAL
   - CENTER FREQUENCY TO 1000
   - SD301 ANALYSIS RANGE TO UPPER LIMIT 50.0
   - INTERNAL REFERENCE
2. SYMBOL ▭ INDICATES FRONT PANEL LOCATION
3. SYMBOL ▭ INDICATES REAR CHASSIS LOCATION

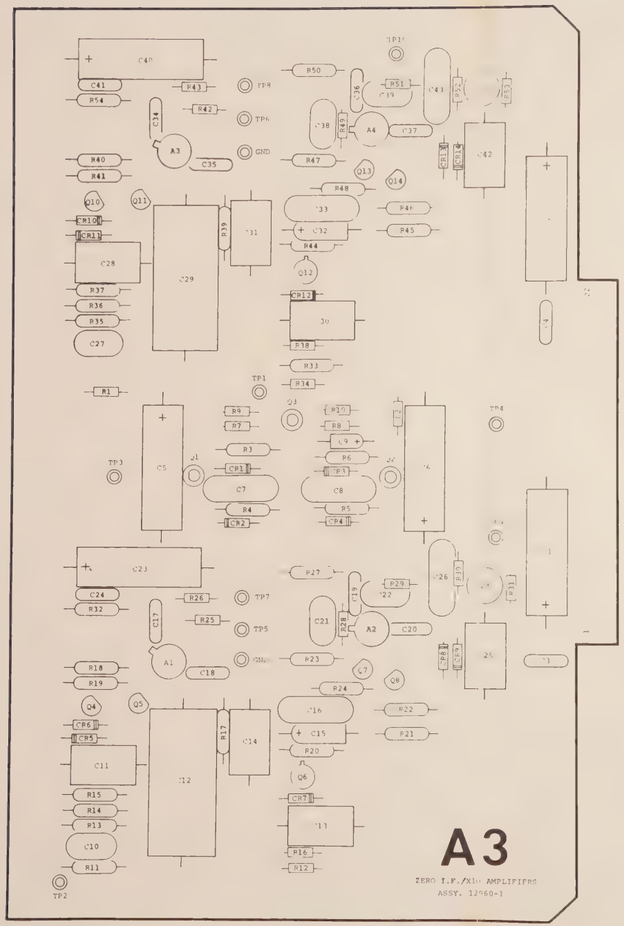
FUNCTIONAL BLOCK DIAGRAM
MODEL 13105
LOW FREQUENCY TRANSLATOR
FIGURE 4-2

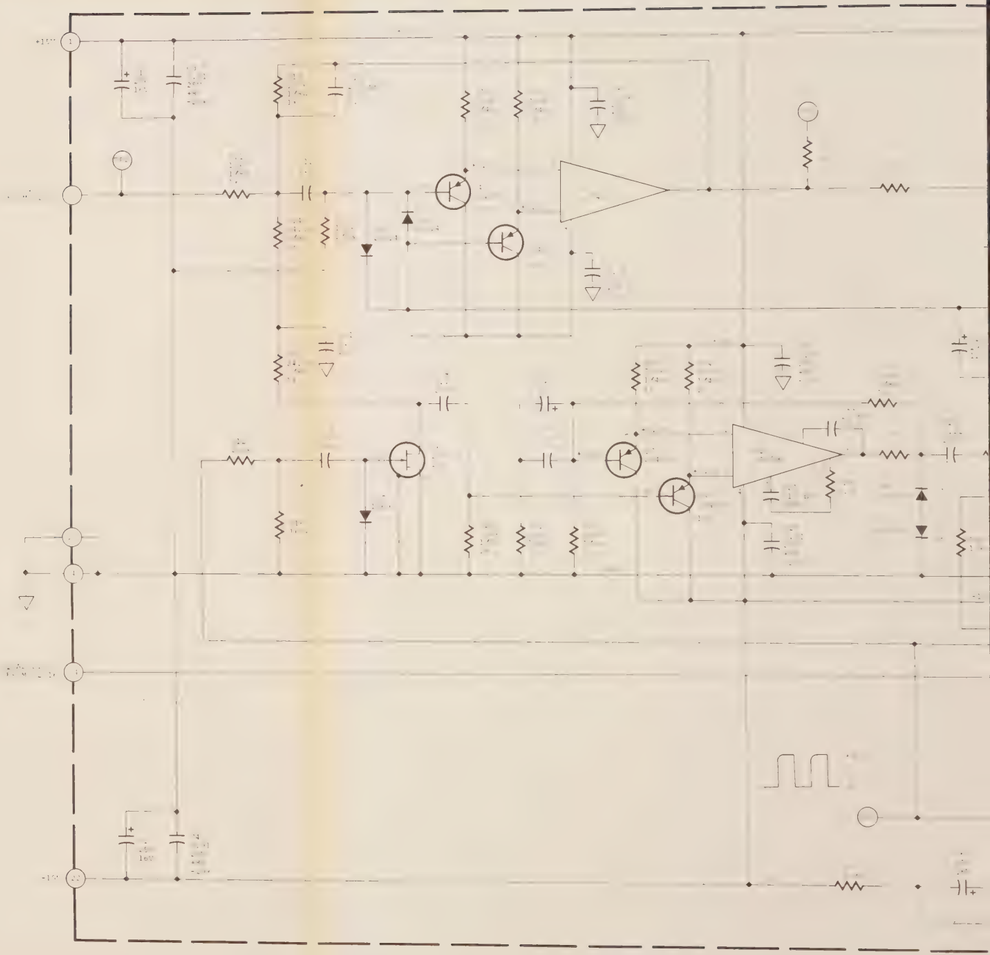

A1
INPUT ASSY 12956-1

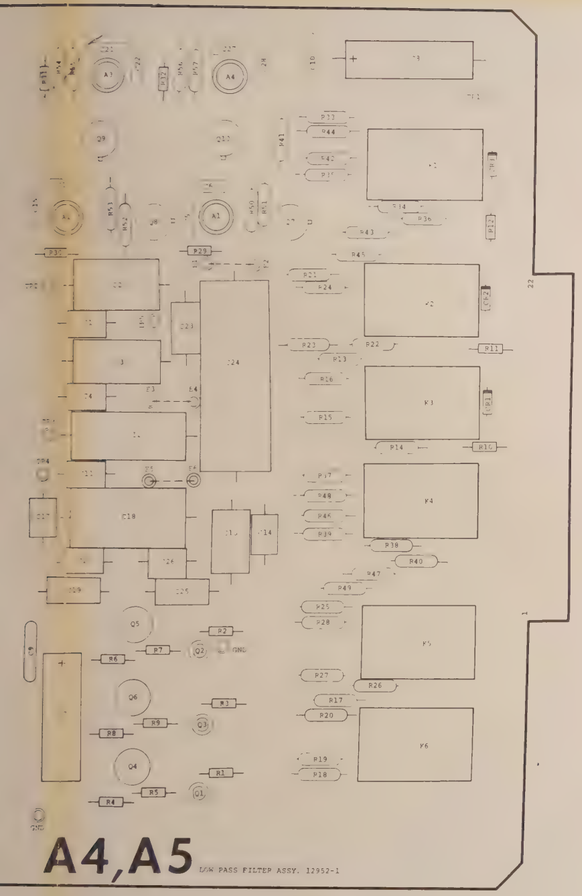

A1
INPUT ASSEMBLY 12956-1
INPUT RANGE (Vrms)/dB (COARSE)
BYPASS
OPER
ZERO
CAL
REMOTE
MODE
FROM A7-21
TO BYPASS RELAY A11-K
DATA INPUT
A1 uA709C
CR1 1N914
CR2 1N914
Q1 2N3391A
+15V
-15V
GND
0.9V P-P = F.S.


A2
I.F. MOD ASSY 12958-1


100 KHz TUNED AMPLIFIER
90 ° PHASE SHIFTER
LIMITER AM
A2
I.F. MOD ASSEMBLY 12958-1
7V P-P
100 kHz
+15V
100 khz
+1.4V
-0V
FROM A11-6, A8-21, A9-21
TO A6-3
+11V
+4.3V
+1.8V
+11.5V
+1.1V
+13.9V
+0.4V
+1V
-5V
-6.2V
+0.3V
300 mV p-p
100 kHz
2N2924
2N4250
2N3391A
2N3646
1N914
AMPL
L1
L2
L3
L4
Q1
Q2
Q3
Q4
Q5
Q6
Q7
CR1
C2
C3
C4
C5
C6
C7
C8
C9
C12
C15
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R17
R22
R23
R24
R25
R26
R27
R28
R29

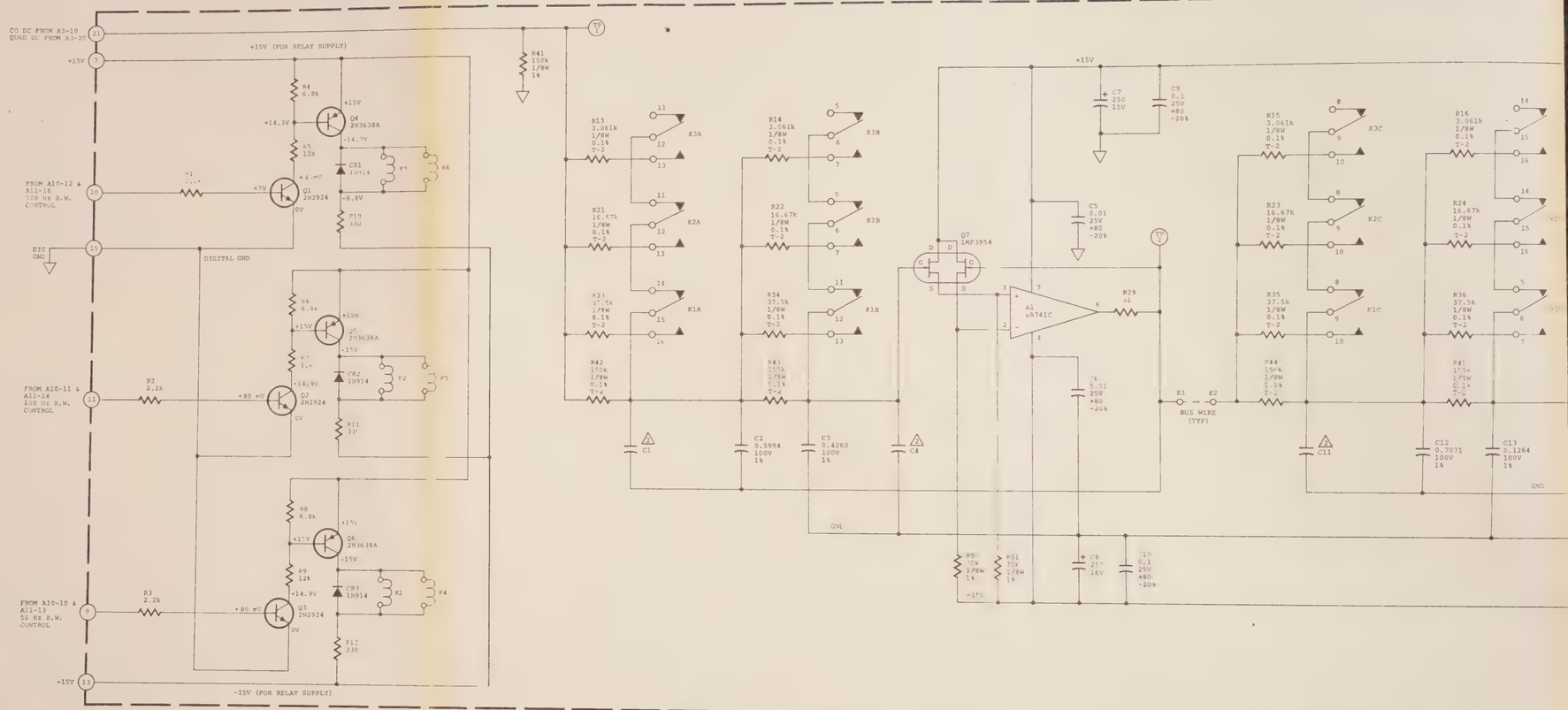

A3
ZERO I.F./X1 AMPLIFIERS
ASSY. 12960-1

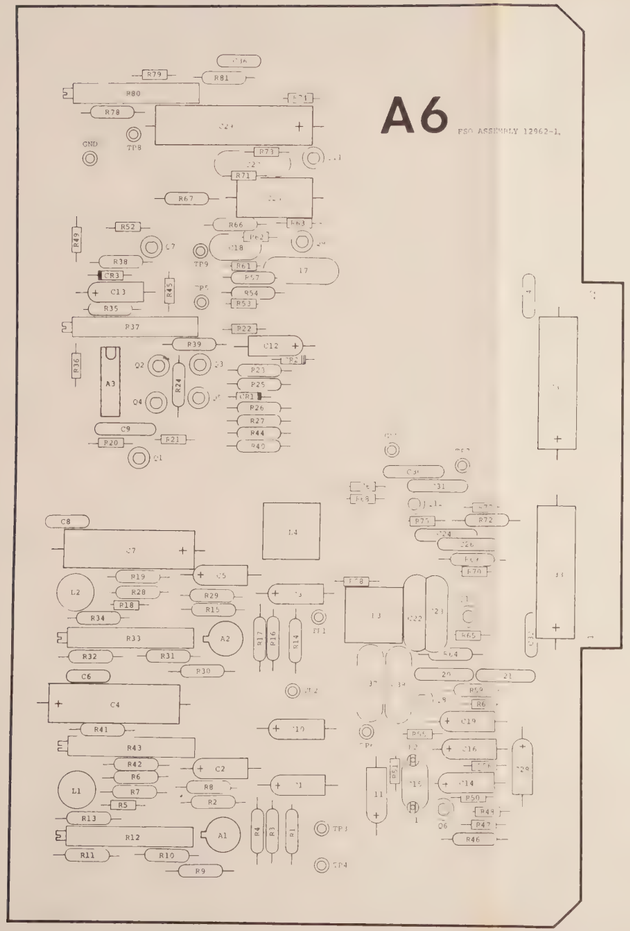


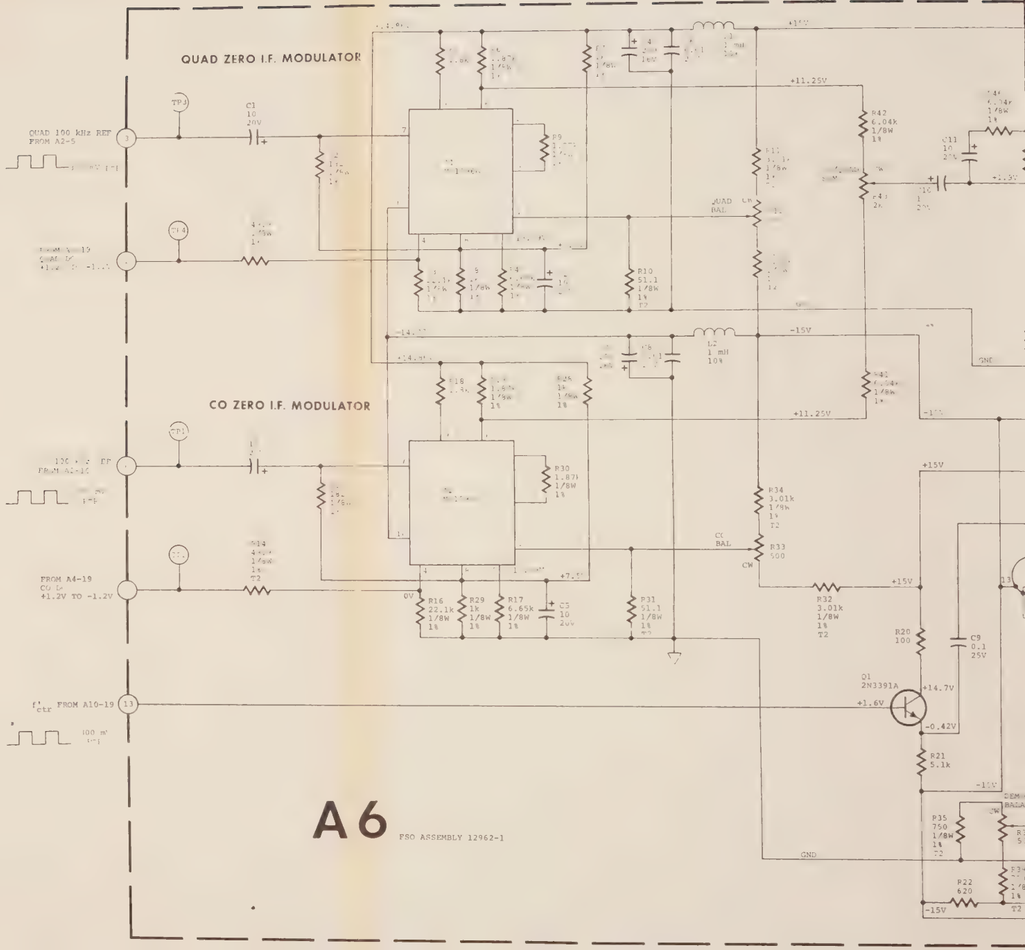


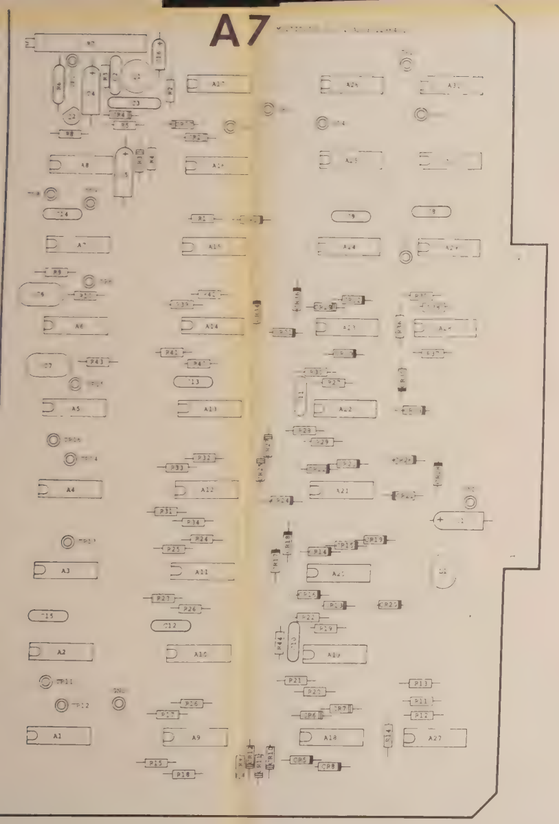
A4,A5

L/H PASS FILTER ASSY. 12952-1




A6
FSO ASSEMBLY 12962-1


QUAD ZERO I.F. MODULATOR
CO ZERO I.F. MODULATOR
A6
FSO ASSEMBLY 12962-1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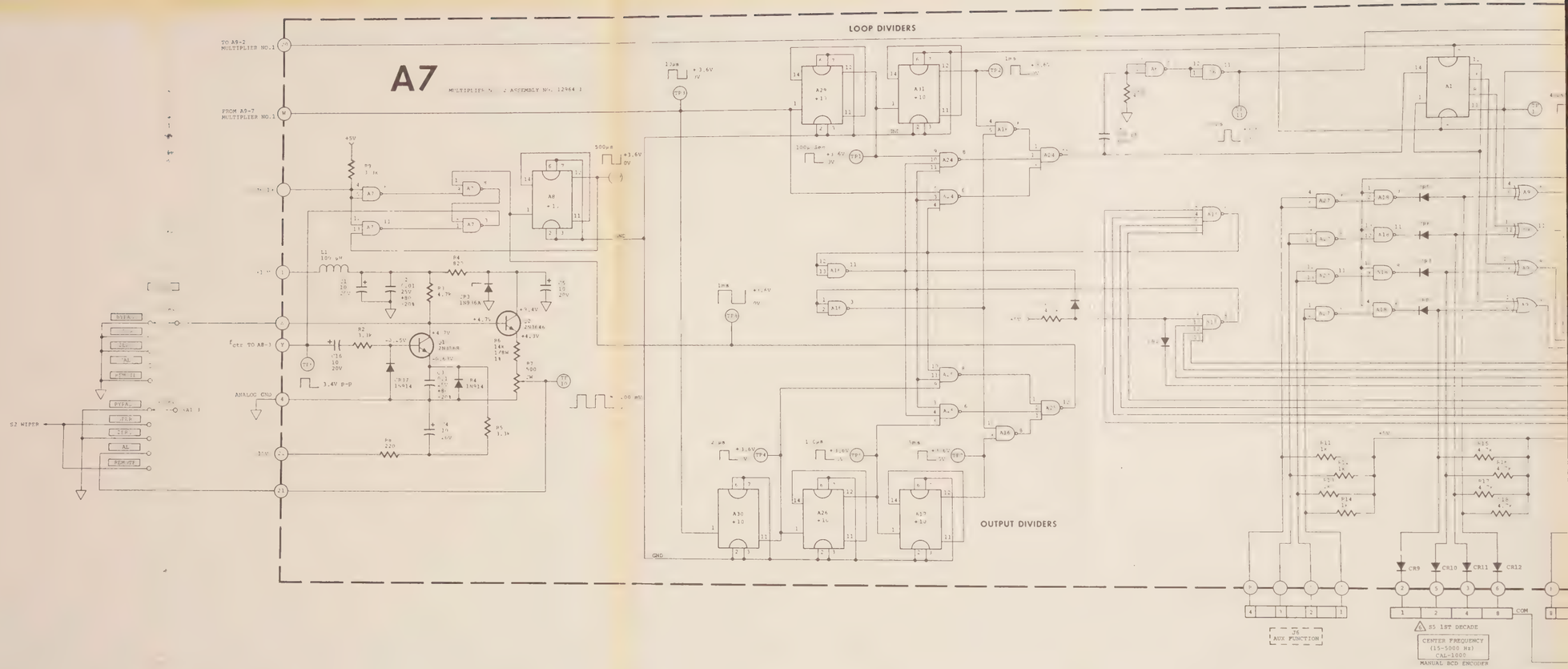
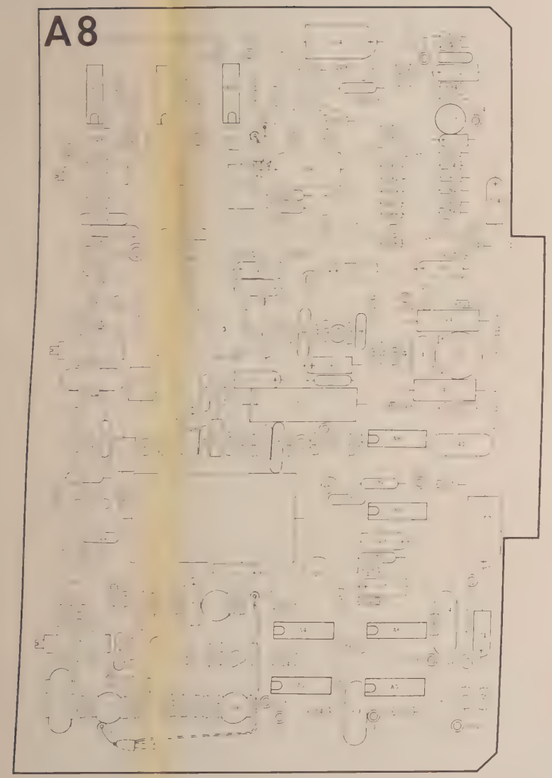
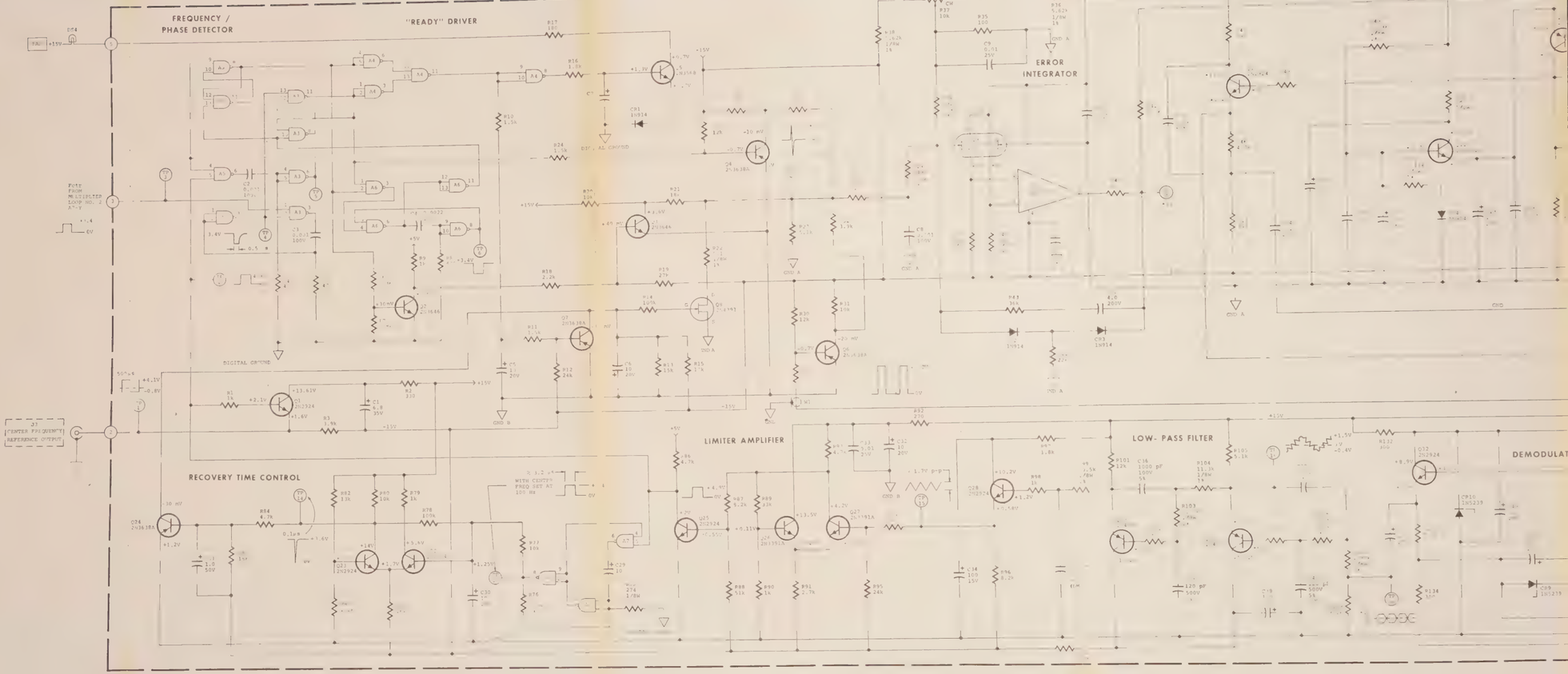
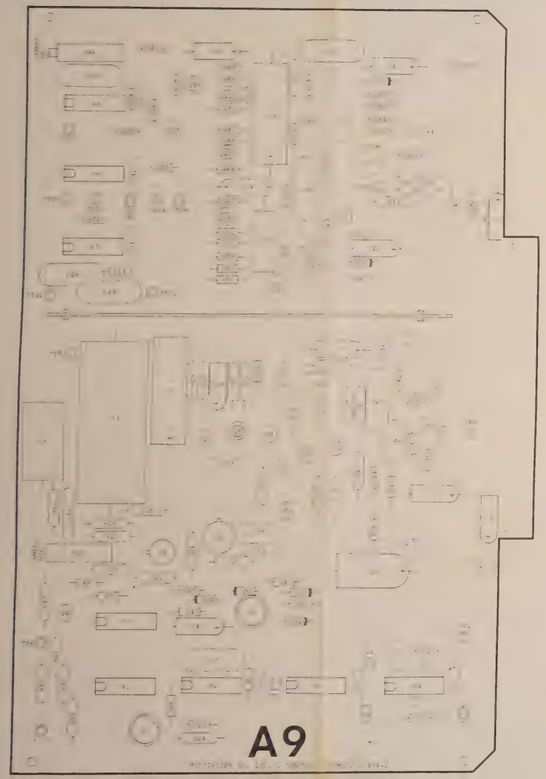
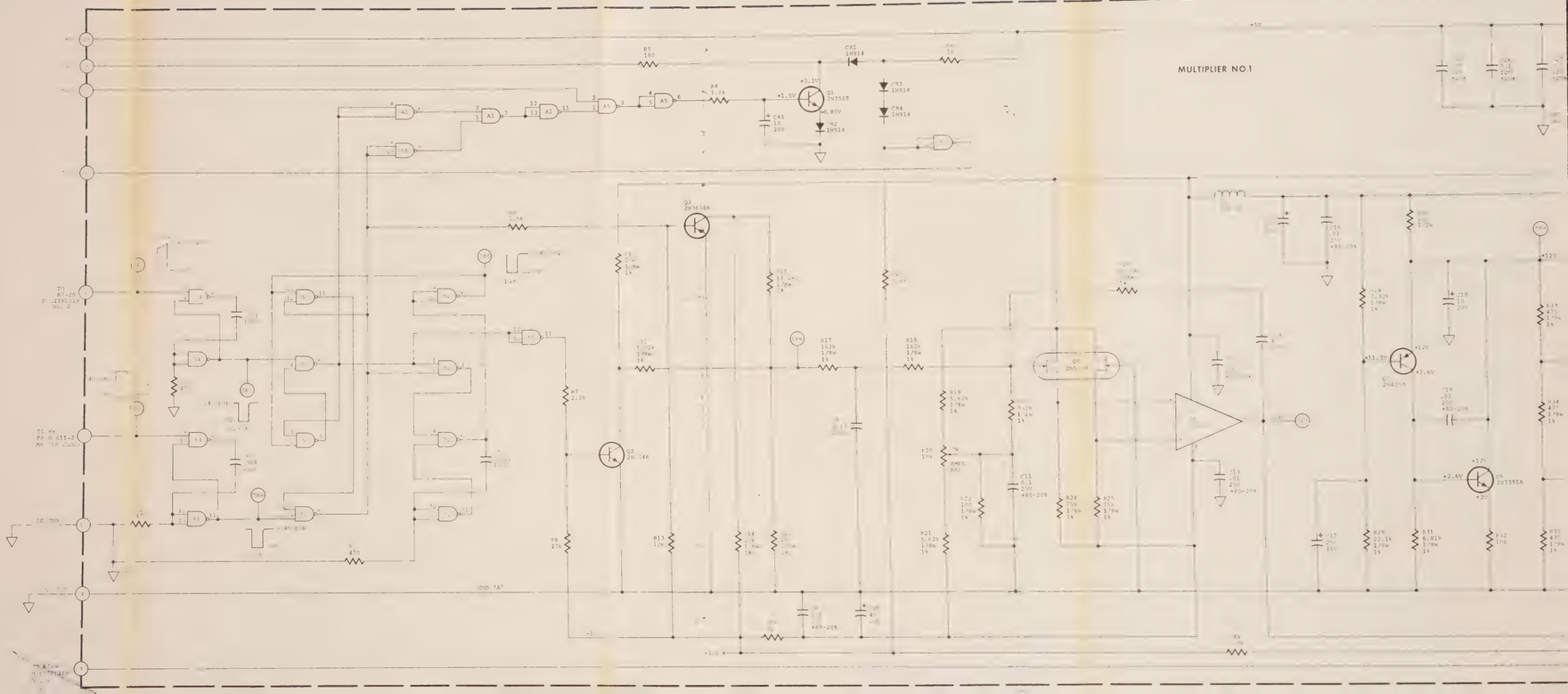

A7
MULTIPLIER A7 ASSEMBLY NO. 12964-1
TO A9-2 MULTIPLIER NO.1
FROM A9-7 MULTIPLIER NO.1
LOOP DIVIDERS
OUTPUT DIVIDERS
S2 WIPER
ANALOG GND
GND
J6
AUX FUNCTION
CR9
CR10
CR11
CR12
COM
CENTER FREQUENCY
(15-5000 Hz)
CAL-1000
MANUAL BCD ENCODER

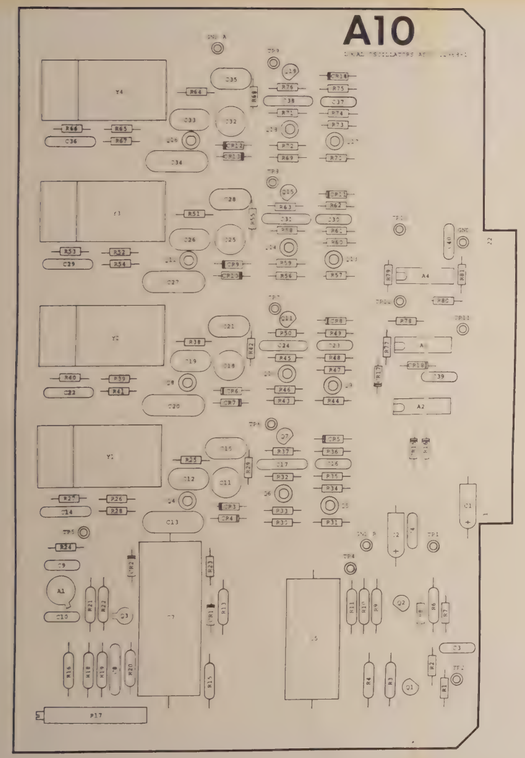
A8

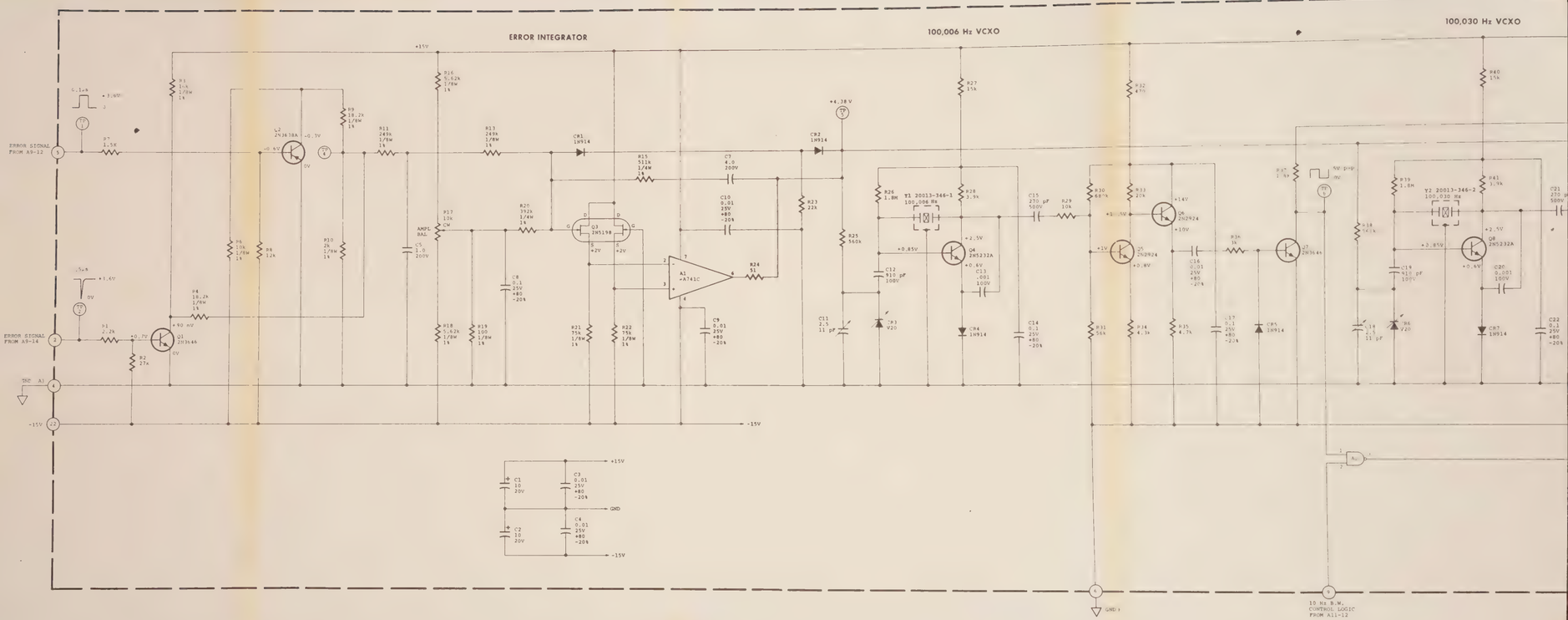



FREQUENCY / PHASE DETECTOR
"READY" DRIVER
ERROR INTEGRATOR
LIMITER AMPLIFIER
LOW- PASS FILTER
RECOVERY TIME CONTROL
DIGITAL GROUND
GND A
GND B
J3
CENTER FREQUENCY REFERENCE OUTPUT
DEMODULAT

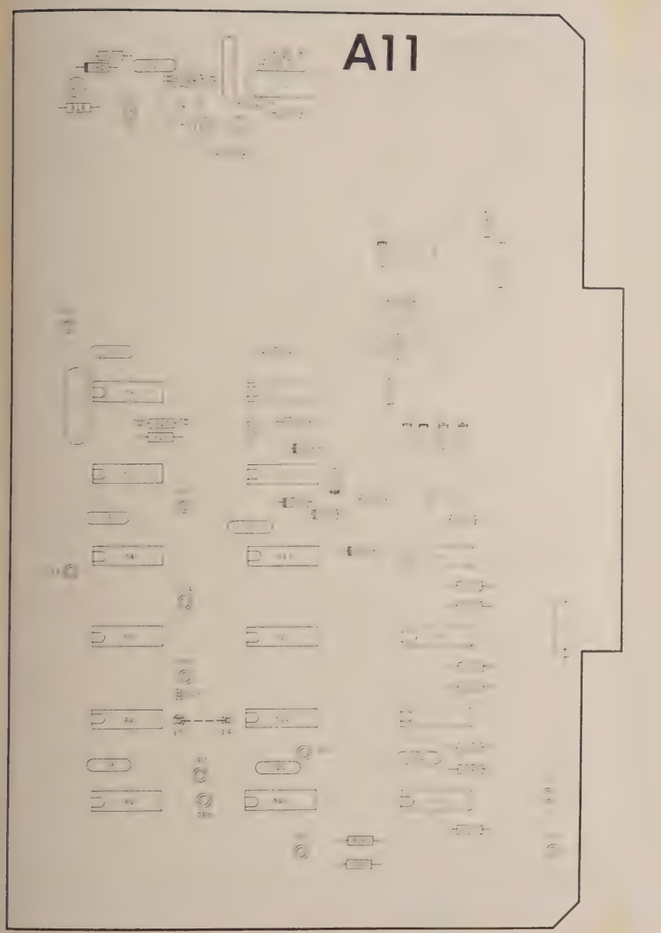

A9

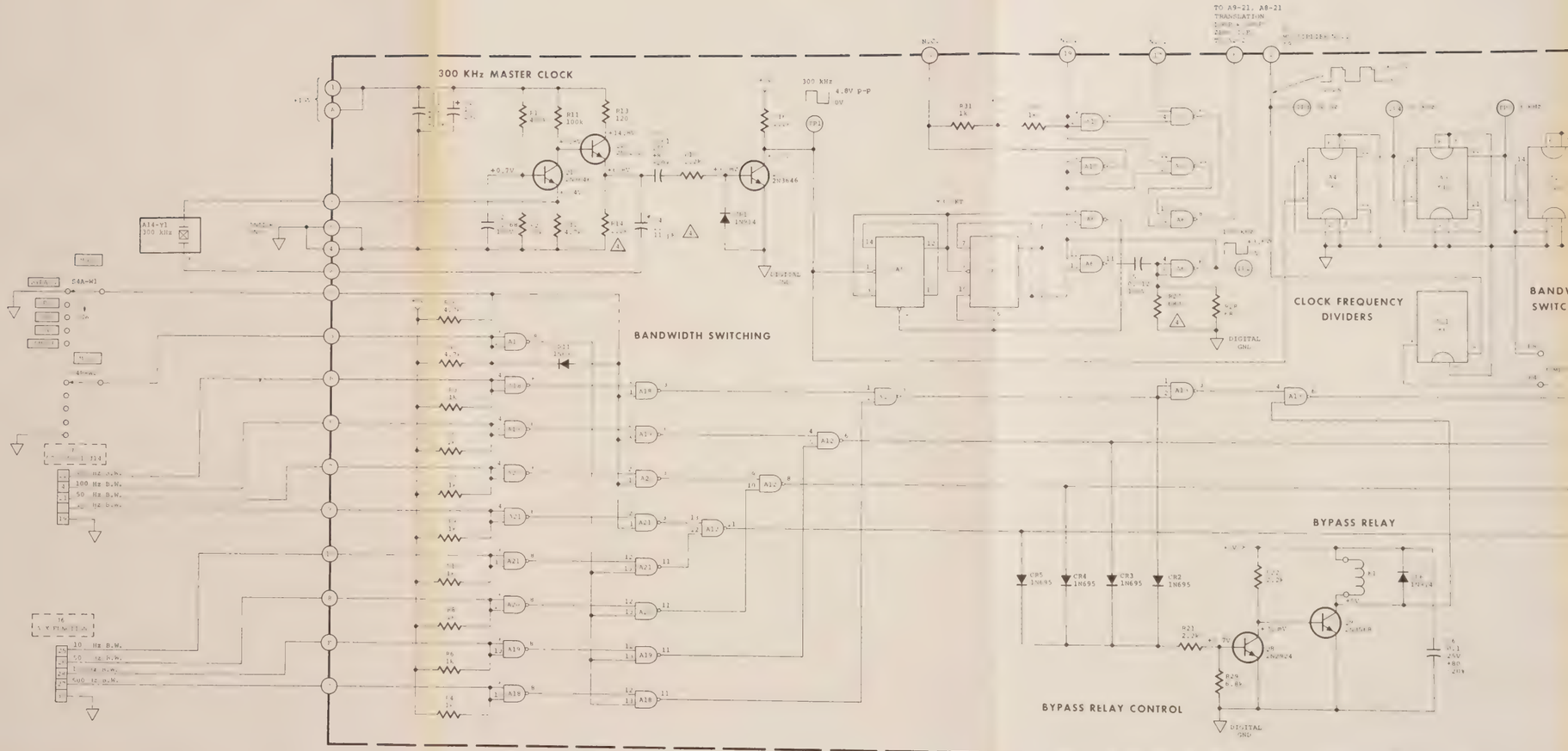

MULTIPLIER NO.1

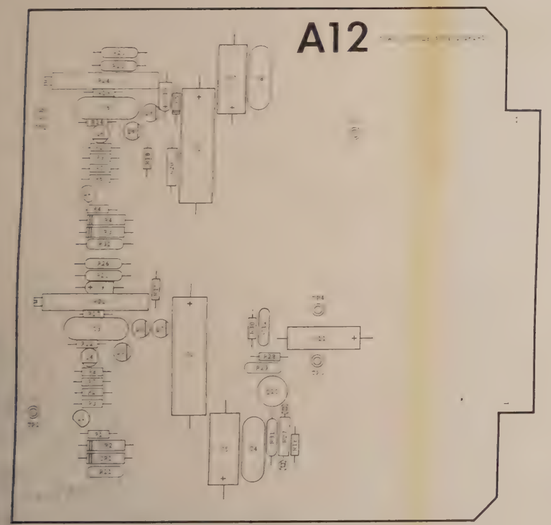

A10

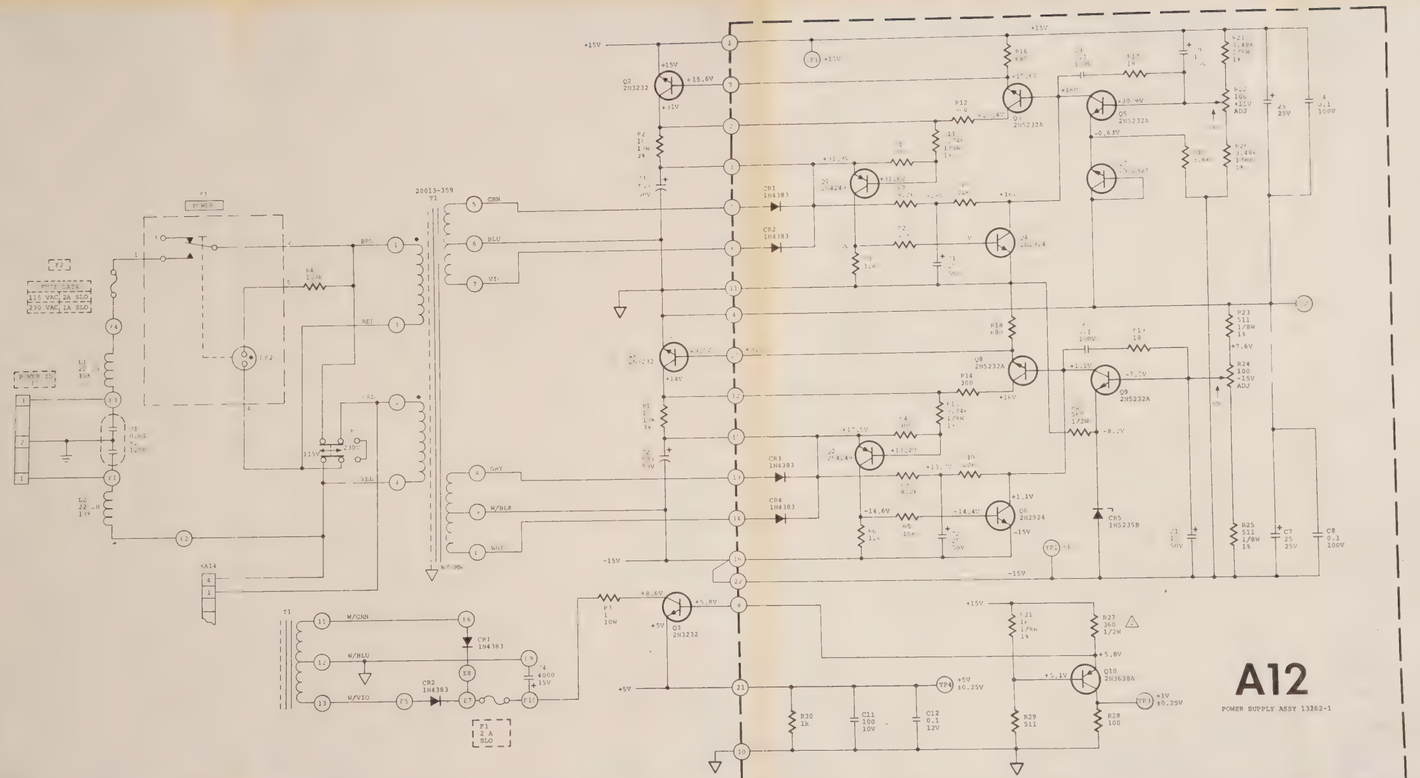

ERROR INTEGRATOR
100,006 Hz VCXO
100,030 Hz VCXO
ERROR SIGNAL FROM A9-12
ERROR SIGNAL FROM A9-14
TRK A1
-15V
+15V
GND
10 Hz B.W. CONTROL LOGIC FROM A11-12
AMPL BAL
Y1 20013-346-1 100,006 Hz
Y2 20013-346-2 100,030 Hz
A1 uA741C
Q1 2N3646
Q2 2N3638A
Q3 2N5198
Q4 2N5232A
Q5 2N2924
Q6 2N2924
Q7 2N3638A
Q8 2N5232A
CR1 1N914
CR2 1N914
CR3 1N914
CR4 1N914
CR5 1N914
CR6 1N914
CR7 V20
CR8 V20
+4.38 V
+3.65V
+1.4V
+90 mV
+0.7V
+2V
+0.85V
+2.5V
+0.6V
+1V
+0.8V
+14V
+10V
4V p-p
0V

A11




300 KHz MASTER CLOCK
BANDWIDTH SWITCHING
CLOCK FREQUENCY DIVIDERS
BYPASS RELAY
BYPASS RELAY CONTROL
300 KHz
4.8V p-p
0V
+0.7V
+14 VDC
2N3646
1N914
A14-Y1
300 kHz
S4A-W1
S4B-W1
100 Hz B.W.
50 Hz B.W.
10 Hz B.W.
1 Hz B.W.
500 Hz B.W.
TO A9-21, A8-21
TRANSLATION
DIGITAL GND
CR5 1N695
CR4 1N695
CR3 1N695
CR2 1N695
CR1 1N914
2N2924
2N3569





REVISIONS						
REV	ZONE	LTR	DESCRIPTION	DATE	CHK'D	APPD
A	—	711	RELEASED	12-7-70		

NOTES: UNLESS OTHERWISE INDICATED

1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%; ALL CAPACITORS IN MICROFARADS ±10%.

2 FACTORY SELECT WITH OPTIMUM VALUE SHOWN.

NOTE: INTERCONNECT CIRCUITRY SHOWN AS REFERENCE.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

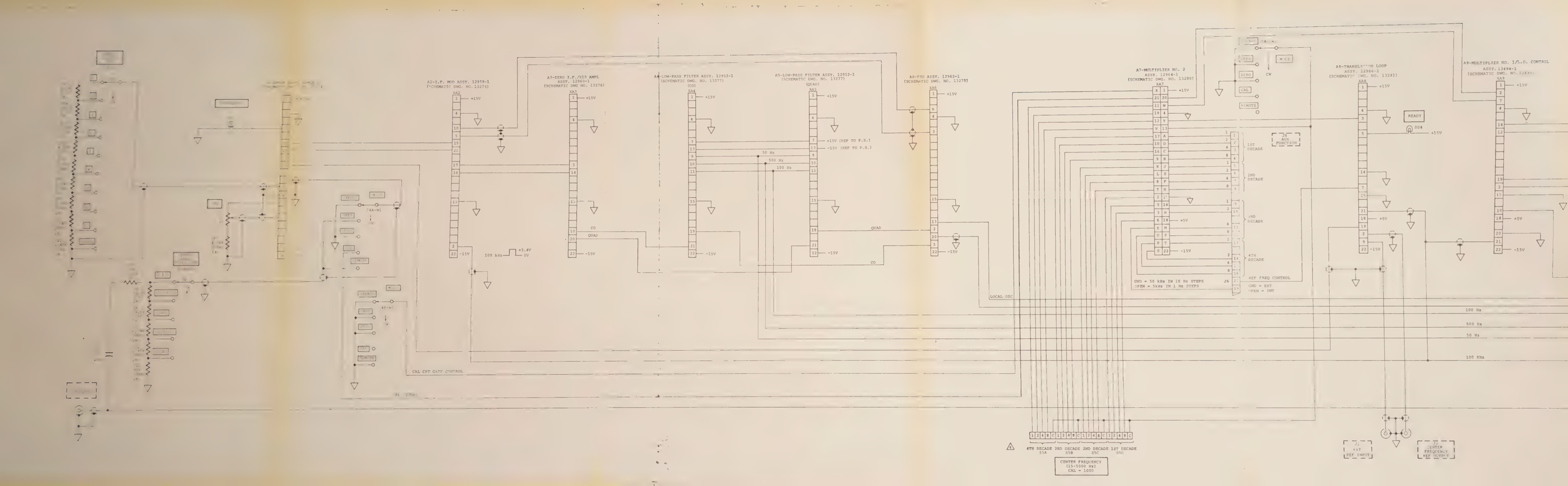
TITLE: SCHEMATIC/COMPONENT LAYOUT — POWER SUPPLY ASSEMBLY 13262-1

A12

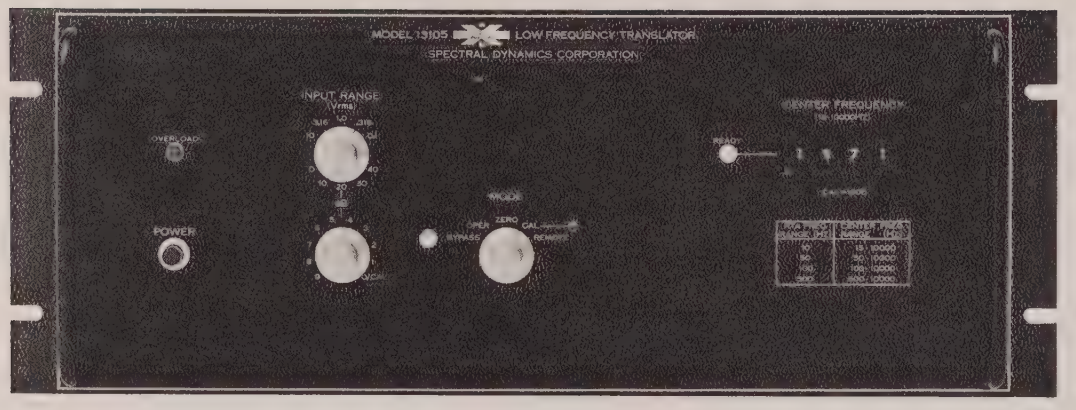
DRAWN	C. CLARK	12-70
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

MODEL	SIZE	DRAWING NO	REV
13105		13264	A

SCALE — SHEET 1 OF 1


A2-I.F. MOD ASSY. 12958-1
(SCHEMATIC DWG. NO. 13275)
A3-ZERO I.F./X10 AMPL
ASSY. 12960-1
(SCHEMATIC DWG. NO. 13276)
A4-LOW-PASS FILTER ASSY. 12912-1
(SCHEMATIC DWG. NO. 13277)
(CO)
A5-LOW-PASS FILTER ASSY. 12952-1
(QUAD)
(SCHEMATIC DWG. NO. 13277)
A6-VCO ASSY. 12962-1
(SCHEMATIC DWG. NO. 13278)
A7-MULTIPLIER NO. 2
ASSY. 12964-1
(SCHEMATIC DWG. NO. 13280)
A8-TRANSLATION LOOP
ASSY. 12966-1
(SCHEMATIC DWG. NO. 13281)
A9-MULTIPLIER NO. 1/L.O. CONTROL
ASSY. 12494-1
(SCHEMATIC DWG. NO. 13279)
XA2
XA3
XA4
XA5
XA6
XA7
XA8
XA9
+15V
-15V
+5V
50 Hz
500 Hz
100 Hz
100 kHz
+3.4V
0V
CO
QUAD
+15V (REF TO P.S.)
-15V (REF TO P.S.)
LOCAL OSC
CAL CKT GATE CONTROL
READY
DS4
1ST DECADE
2ND DECADE
3RD DECADE
4TH DECADE
AUX FUNCTION
REF FREQ CONTROL
GND = EXT
OPEN = INT
GND = 50 kHz IN 10 Hz STEPS
OPEN = 5kHz IN 1 Hz STEPS
J6
4TH DECADE 3RD DECADE 2ND DECADE 1ST DECADE
55A 55B 55C 55D
CENTER FREQUENCY
(15-5500 Hz)
CAL = 1000
J7
EXT REF INPUT
J8
CENTER FREQUENCY REF OUTPUT
100 Hz
500 Hz
50 Hz
100 KHz

MODEL 13105-1
LOW FREQUENCY
TRANSLATOR



FOR INCREASED FREQUENCY RESOLUTION AND SIGNAL TO NOISE ENHANCEMENT

FEATURES

- Narrowband "zoom-in" resolution of 10, 50, 100 and 500 Hz
- Complete internal synthesizer for stand-alone operation
- Continuous narrowband operation 15 Hz to 10 kHz
- Built-in calibration for absolute reference
- Remote programmability of frequency window, center frequency and operational mode
- Input level adjustment in 1 dB steps
- Externally programmable to 50 kHz
- Greater than 55 dB dynamic range
- Sharp cutoff, active, Chebychev filter for precise band determination and phase stability
- Single crystal phase lock loop for optimum stability
- Directly compatible with SD301 series Real Time Analyzers

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO
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TELEPHONE 714—270-2511 • TWX 910-335-2032

11-72

GENERAL DESCRIPTION

The Low Frequency Translator is a precision bandshifting device designed to greatly improve frequency resolution when performing narrowband spectrum analysis.

Used in conjunction with the SD301 series Real Time Analyzers, the Model 13105-1 permits a selected frequency range or "window" (10, 50, 100 or 500 Hz) to be placed anywhere in the frequency spectrum from 15 Hz to 10 kHz. By using an external frequency synthesizer, the frequency window can be placed as high as 50 kHz.

Front panel digital thumbwheel switches control the internal reference frequency permitting the center frequency of the selected window to be set in 1 Hz steps. The input range selectors provide 0 to 49 dB attenuation of the input signal in 1 dB steps. An input overload indicator provides warning when the level exceeds the preset input range level. A ready indicator lights to show that the instrument is ready to operate at selected center frequency. The Bypass mode can be manually set, but is also automatically selected when the Real Time Analyzer is not set to one of the translatable ranges. An internal calibration signal is furnished to assure unity gain. The window center frequency, bandwidth and operational modes can be programmed externally.

In addition to furnishing increased resolution during a spectrum analysis, the Model 13105-1 also permits significant improvements in signal-to-noise ratio for detecting or observing periodic signals buried in random background noise. The amount of signal-to-noise enhancement obtained is a ratio function of the broadband spectrum width to the translated band and is improved with each narrower band selection as illustrated in the typical application on the opposite page. The Low Frequency Translator plugs directly into the Real Time Analyzer and does not affect normal analyzer operation.

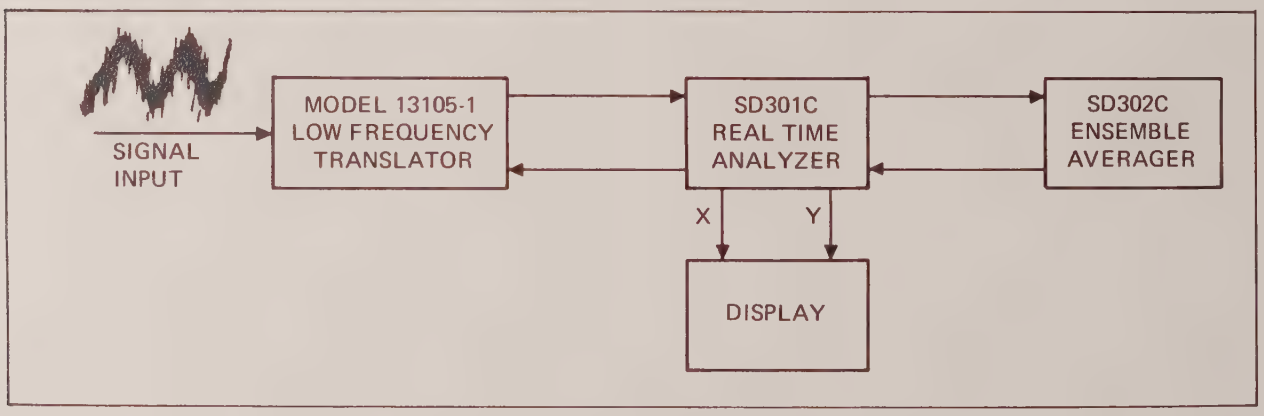


Figure 1. Typical Interconnection — Model 13105-1

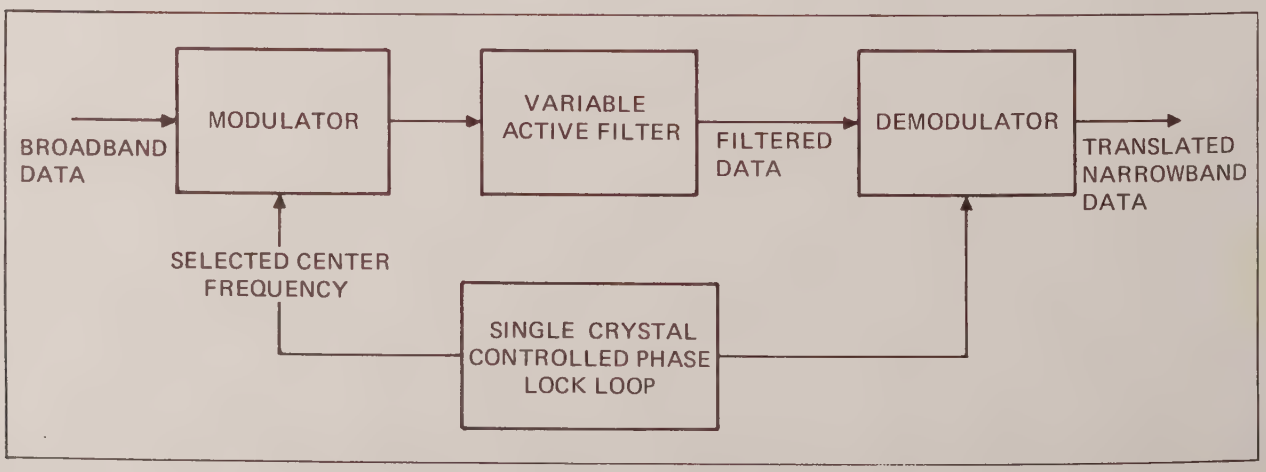


Figure 2. Basic Concept of Operation

TYPICAL APPLICATION – Expanded Frequency Resolution

Figure 3.

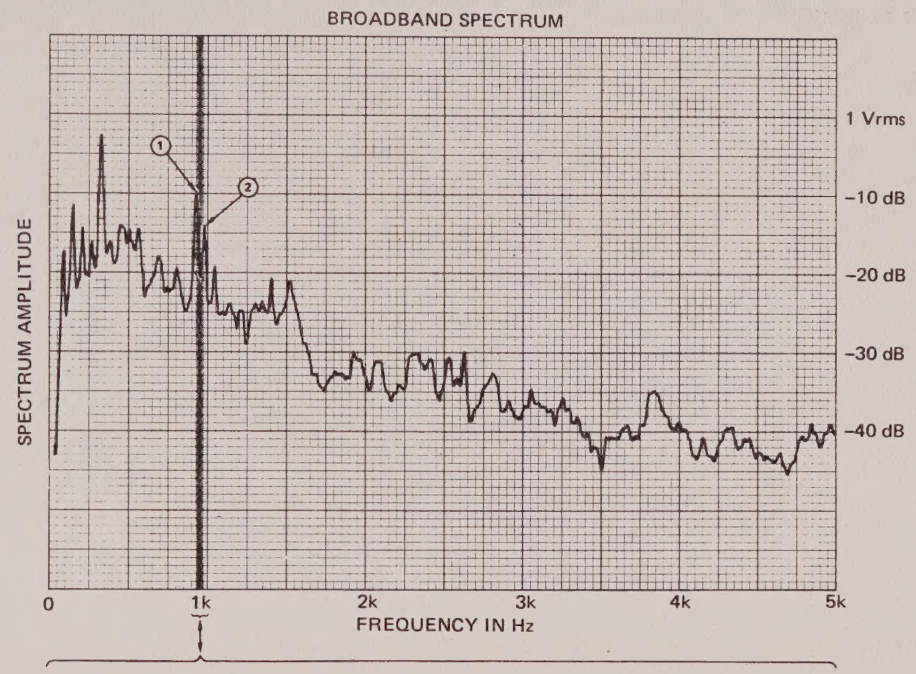
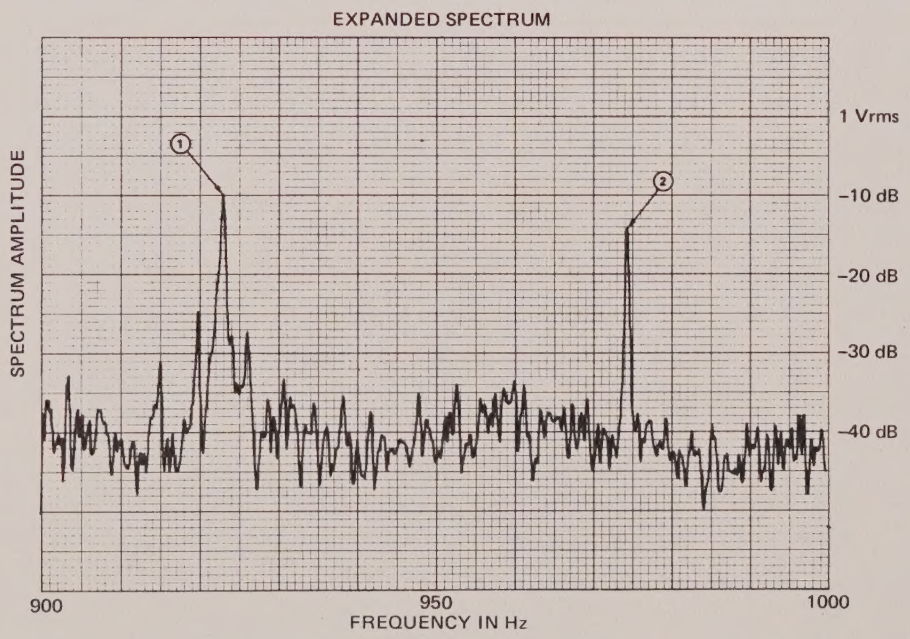


Figure 4.



If a frequency area of interest is seen anywhere up to 10 kHz, the full 500 line resolution of the series SD301 Real Time Analyzer can be made to "zoom in" and expand the selected area. In the example above, data first seen on the 5 kHz frequency range is then examined in more detail with 50 times better resolution. By positioning the 100 Hz range of the SD301C Real Time Analyzer at 950 Hz, the exact frequency of periodic tones is determined with 0.2 Hz resolution. The level of periodic components is unaffected by translation, but noise components are greatly reduced using the 13105-1 – in this example by 16 dB.

$$db = 20 \times \log \left(\sqrt{\frac{5000}{100}} \right).$$

By using the 10 Hz translated range, additional S/N enhancement of up to 30 dB and frequency resolution of 0.02 Hz up to 10 kHz are quickly achieved.

SPECIFICATIONS*

DATA SIGNAL INPUT . . . . . .

Frequency Ranges	Filter Spacing	†Band Covered by Single Sweep
10 Hz – 10 kHz	.02 Hz	10 Hz
50 Hz – 10 kHz	.10 Hz	50 Hz
100 Hz – 10 kHz	.20 Hz	100 Hz
500 Hz – 10 kHz	1.00 Hz	500 Hz

†Bandwidth: Four data bandwidths, 10 Hz, 50 Hz, 100 Hz and 500 Hz as selected by Analysis Range switch on SD301. Higher bandwidth selection in the SD301 automatically causes translator to go to Bypass Mode.

Amplitude . . . . . 0.1 Vrms to 10.0 Vrms (maximum)
Impedance . . . . . 100 kΩ

DATA SIGNAL OUTPUT (TO RTA)

Frequency . . . . . Translated from input ranges as follows:

Input	Output
10 Hz – 10,000 Hz	1.0 – 11 Hz
50 Hz – 10,000 Hz	5.0 – 55 Hz
100 Hz – 10,000 Hz	10.0 – 110 Hz
500 Hz – 10,000 Hz	50.0 – 550 Hz

Impedance . . . . . Less than 500 Ω
Linearity . . . . . ±0.50 dB to at least −50 dB reference to full scale
Amplitude . . . . . 0.316 Vrms = full scale

INTERNAL REFERENCE SIGNAL . . . . Selectable by front panel digital switch from 15 Hz to 10,000 Hz in 1 Hz increments.

Stability:

.002% short term – 24 hours
.01% long term – 6 months

Frequency selected is displayed at center of SD301 sweep range. No external signal source is necessary with translator.

EXTERNAL REFERENCE INPUT . . . . . Translator will operate up to 50 kHz with external reference input (100,015 Hz to 150,000 Hz reference input).

CALIBRATION . . . . . Internal one-step calibration signal at selected reference frequency. Will always appear at center of display.

REMOTE . . . . . Provide for remote programming of Reference Frequency Selection and Mode Selection.

REFERENCE FREQUENCY OUT . . . . . Amplitude . . . . . 5V p-p; 3 mA max.
Impedance . . . . . less than 600 Ω

4-bit BCD output indicating reference frequency

POWER . . . . . 115/230 Vac, 50–400 Hz primary input

DIMENSIONS . . . . . Height . . . . . 17,8 cm (7")
Width . . . . . 48,3 cm (19")
Depth . . . . . 35,6 cm (14")
Shipping Weight . . . . . 11 kg (24.4 lb)

*Specifications subject to change without notice.